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Prefatory note.

This volume contains papers on HYGIENE which were read at the Second All-India Sanitary Conference. It has not been found possible to reproduce all illustrations, plans, etc., attached to the various papers, and anyone specially interested should apply to the authors.

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PART I.

TOWN-PLANNING, CONGESTED AREAS AND BUILDING BYE-LAWS.

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All-India Sanitary Conference, Madras, November 1912.

TOWN PLANNING NOTES

BY

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The draft of the Bombay Town Planning Act embodies the suggestions contained in the note marked appendix 5 in the printed proceedings of last year's conference, and in that respect really combines the German Act principle of 'redistribution' and the English Act principle of 'betterment,' the former giving power to alter the shapes of plots so as to render them more suitable for building purposes, and the latter enforcing contributions from owners towards costs in proportion to the amounts by which their lands are 'bettered' by the scheme that is taken in hand. In the English Act the principle of redistribution has not been included, most probably because the holdings in England are usually fairly large in extent and can therefore be subdivided into plots of convenient shapes and sizes without disturbing ownership. In any area where the holdings are fairly large there is less necessity to rearrange them, but in Bombay the holdings are mostly small and irregular in shape, and power to rearrange them is absolutely necessary to promote development by carving out plots of suitable shapes and sizes, and to give every one access to proposed roads. Whether the holdings be small or large, one great advantage of redistribution is the power to cut out plots from the larger holdings and to allow them to such owners as are dispossessed from their lands by the advent of roads, market places and other public sites, for thereby the capital cost of a scheme is reduced to the extent of the value of the plot allotted, and the owner of the holding out of which the allotted plot is carved will have his cash contribution for 'betterment' reduced by the cash value of such allotted plot.

Example.—Suppose that A's land is worth Rs. 500 and it is required for a school site, and it is possible without causing much inconvenience to B to allot a plot worth Rs. 500 to A out of B's holding. Instead of paying Rs. 500 in cash to A and depriving him of a holding, he should be allotted a plot of equal value out of B's holding and the contribution leviable from B for the betterment of his remaining land is thereby reduced to the extent of Rs. 500.

In every case therefore, whether holdings are large or small, it would appear to be advantageous to have the power to redistribute, which may be used as much or as little as may be found to be expedient. In some schemes it may be found necessary to arrange all the plots; in some it may be found necessary only to rearrange a few scattered plots, whilst in others it may not be found necessary to rearrange any plots. Under section 60 of the English Act, a local authority can be authorised to acquire compulsorily any land comprised in a scheme, and such a power if freely given, would enable holders dispossessed by roads to be offered plots from the larger holdings, and would also give power to acquire strips of land to round off plots and make them of more suitable shape, but there seems to be no power in the English Act to compel owners to accept such strips being added to their holdings, and a proper rearrangement of plots could not therefore be made without the consent of all the holders concerned. Wider powers are needed, and whatever method is adopted to rearrange the plots the wishes of the holders should be followed as far as may be consistent with the objects of the scheme.

2. Appendix 5 of last year's proceedings contain a note on the rearrangement of plots and the method of calculating the expenses leviable on account of costs. It is proposed now to amplify that note by diagrams showing some examples of rearrangement and of estimates of 'betterments' in schemes actually worked out. Diagram I shows a rearrangement of 4 plots along whose

southern boundaries there is a proposed road. Excluding the portions of the plots that are absorbed by the road, it will be noticed that the greater part of the remaining portions of the plots are not displaced by rearrangement but that their boundaries are trimmed. A new plot has been provided for the holder of C, who has very little land left after the road land has been taken from this plot.

Diagrams II and III show alternative rearrangements of six plots which are intersected by a proposed road. In Diagram II the small plot F is wholly absorbed by the larger plot E, whilst in the suggested alternative rearrangement (Diagram III) the holder of F is allotted a suitable plot out of E. In each case all the 'final' plots have access on the proposed road. In one arrangement the plot B keeps its position and is given access by means of a private roadway, whilst in the other rearrangement the final plot B has a good frontage. Other forms of rearrangement can easily be suggested, but the form finally decided upon should be that particular suitable one which conforms most closely to the wishes of the holders concerned.

Let us now consider the loss or gain to a holder when the shape or position of his plot is changed. Each owner will receive an adequate equivalent for any decrease in the value of his holding due to the rearrangement of plots, and he will be charged for any increase in it due to the same cause. To estimate such decrease or increase due merely to rearrangement, the plots will be valued as on a particular date, such as the date of notification in the Government Gazette of an intention to plan, and without reference to the improvements contemplated. This is precisely what is done under the Land Acquisition Act at present. A notification appears and the valuation of the land at the date of the notification is made by the acquiring officer without reference to future enhancement. So in this case, a notification appears and valuations of a plot in its original and its rearranged or final shape are made and the difference in its value due to mere rearrangement is thereby obtained. Let us take as an example, plot A of our second diagram. In its original shape it is valued say at Rs. 1,000; in its final shape without reference to the fact that a road is coming it is valued say at Rs. 800. Then the loss to the holder of A is Rs. 200 and he would be credited with that amount.

Take the case of plot F in the third diagram. In its original form its value say is Rs. 100. In its final form without reference to the fact that a road is coming its value say is Rs. 300. By mere rearrangement therefore its value has increased by Rs. 200 and the owner must be debited with that amount.

The idea of credit and debit mentioned in the above examples is the clue to the method suggested to minimise the needless raising of capital. When a road is constructed the plots in their final shape will generally increase in value, and the amount of such increase measures the real 'unearned increment' or as it is called the 'betterment.' It is clearly reasonable that the holders should contribute some portion of their 'betterment' towards constructional and other expenses incurred upon works from which they have derived their profit, but there is no necessity to take a greater portion of their 'betterment' than is actually required for expenses. In Germany all expenses can be met by distributing costs amongst the holders in proportion to the benefits received by them individually, but the English method is distinctly fairer, whereby the proportion of 'betterment' that can be taken is limited to one-half, and if any more money is required the local authority must get it either by general taxation or from other sources. For the purposes of this note the English maximum limit of one-half has been taken and diagram IV shows how a holder's dues in any particular case are calculated. The dotted lines in the diagram indicate the 'final' or rearranged plot, which in this case is seen to be less both in area and value than the original plot. A ledger account is made with each holder on the credit side of which will be the decrease in the value of his plot due to rearrangement, and on the debit side will be the portion of his 'betterment' which is levied for expenses. The balance if on the debit side will be levied from him, and if on the credit side will be paid to him. If a town planning scheme is of any real use to the holders it will be generally found that the balance will be on the debit side, so that

instead of paying them in cash for any land they give up and afterwards levying a contribution from them out of their 'betterment,' it will be only necessary to levy from them, or pay to them, the difference of these two items and thereby the amount of capital to be raised will be materially diminished. The balance due from a holder may be paid either immediately in lump sum or in such instalments including interest and sinking fund charges as may be fixed for the scheme, *e.g.*, if a holder's dues are Rs. 1,000 then he could pay 30 yearly instalments of about Rs. 60 if money is borrowed at 4 per cent and the sinking fund charges calculated on a 3½ per cent basis. Diagrams V, VI, VII show actual schemes worked out on a paper in the area as of Santa Cruz and Vilepadle in the island of Salsette.

Diagram V.

There is already an existing road from the Railway station opening up the plots, so that the scheme is much simplified and its works and purposes consist of :—

(*a*) rearranging the plots,

(*b*) widening the existing road, constructing a storm water drain, providing lamps and planting trees.

The mere rearrangement of plots yields a profit of Rs. 1,248 (*vide* paragraph 3 below) and one-half the 'betterment' is estimated to yield Rs. 1,329, so that a sum of Rs. 2,577 can be recovered from holders, whilst the total constructional expenses are estimated as Rs. 3,747. The local authority will have to contribute from its general revenues towards the expenses of this scheme a sum represented by the difference of these two figures, *i.e.*, a sum of Rs. 1,170.

Diagram VI.

This scheme comprises plots neighbouring a *nalla* which is used as a fair weather track. Some of the plots already contain bungalows. The purposes and works of the scheme comprise :—

(*a*) giving access to all plots,

(*b*) widening the *nalla* to 40′ and constructing a made road along it with the necessary storm water drains.

The estimated expenses of the scheme are as follows :—

	Rs.
Constructional works	8,219
Land compensation	1,157
Valuation and preliminary expenses of preparing the scheme	1,500
Total ...	10,876

One-half the betterment is estimated at Rs. 8,128; so that the cost of the scheme to the local municipality will be Rs. 2,748.

Diagram VII.

This is finally large scheme for a small locality and includes the acquisition of land for a future 70 feet main tramway road and the present construction thereon of metalled road 30 feet wide, the remaining 40 feet of land being filled up where necessary and the necessary gutters made and trees planted. Most of the plots are rearranged. The expenses of the scheme are estimated as follows :—

	Rs.
(*a*) Rearrangement of plots	14,952
(*b*) Constructional expenses	16,334
(*c*) Valuation and preparation expenses	3,000
Total ...	34,286

of which Rs. 13,912 can be met from one half of the estimated 'betterment.' As this is a main road it is but right that the frontagers should not have to pay for its entire cost. The figures show that one half the 'betterment' practically pays for all the land (*c*).

3. It will be seen from the illustrations given above that "rearrangement" and a limited 'betterment' contribution do not necessarily pay all the costs of a scheme. The local authority must find the amount by which they fall short of the total expenses. Naturally the local authority will not be anxious to take up schemes that will cost them too much money, but every scheme will cost them much less than under the present system where the frontagers who benefit most by the rapid appreciation in the value of their lands by the advent of a new road give up no portion of their 'unearned increment' towards its construction.

In homogeneous tracts mere rearrangement of plots lessens capital cost, for every plot that is rearranged is made more suitable for building purposes and is therefore of greater value per square yard than before it was so arranged. This can easily be seen by rearranging the two plots formed by the diagonal of a square into two rectangular plots formed by a line through its centre parallel to the sides.

4. In England, the individual benefit derived from a town planning scheme, *i.e.*, the 'betterment,' is calculated after all the constructional works have been completed; but under a system of rearrangement of plots as already described, there are advantages in estimating it at the same time as the original and final plots are valued, *i.e.*, before the works are started, and to guard against possible errors the owners of the major number of plots, or the local authority, might be given an opportunity of demanding its revision after the constructional works have been completed. There is always the chance that the owners would not combine to demand a revised valuation, especially if they are made to pay for it, whilst in small schemes, such as the construction of accommodation roads, which are a pressing need in growing suburbs, the owners would probably be content to pay a small yearly sum for the substantial benefits they will receive without troubling themselves too much about whether the valuation upon which it is based absolutely coincides with the actual state of things when the works are complete. If the local authority has a favourable balance at its disposal, sufficient to carry out the contemplated works, there is no need for haste in calculating the 'betterment,' but if it has not, which is generally the case in the Bombay suburbs, the sooner the 'betterment' is estimated the sooner will there be some sort of security to go upon wherewith to raise the necessary loan, and even if a revision of the 'betterment' is demanded after some years, and it is found that the valuations of it made by the arbitrator in the first instance were too high, the local authority could then consider ways and means to meet the deficit. By assessing individual contributions before the works are started, the local authority will have something at any rate to go upon, and even if it is afterwards found on revision that the contributions were over-assessed in the first instance, a growing municipality will be in a better position to incur more expenditure from general funds to meet the excess, by reason of the interval of time that has elapsed between the original and revised valuations.

The English method of post valuation of 'betterment' has the advantage of allowing an accurate calculation of 'betterment' being made, but it does not allow a set-off being made at once in each individual holder's ledger account and it gives the local authority only a possible future security to rely upon when a loan is required to carry out the scheme works. The initial capital would be increased by holders demanding to be paid for the portions of their land absorbed by roads, but a reduction under this head could be materially effected if instead of paying holders immediately for such portions of their land and afterwards levying a 'betterment' contribution from them, they were paid interest, say, at 4 per cent on the amounts due for such portions during the interval between the introduction of a scheme and calculation of their 'betterments.'

Both the systems of prevaluation and post valuation of betterment yield correct accounts in the end, but in the former the initial financial responsibility is placed upon the holders and in the latter it is placed upon the local authority.

The 'betterment' figures given for the schemes illustrated by diagrams V, VI, VII (*vide* paragraph 2 above) are estimates made before the works have been started. If the 'betterment' is to be calculated after the works have been completed the effect will be as follows:—

Diagram V.—Scheme.

The local authority would have initial security for Rs. 1,248, and would have to raise initially a sum of Rs. 2,499 on the security of their general funds instead of a sum of Rs. 1,170.

Diagram VI.—Scheme.

The local authority would have to raise initially a loan on the security of their general funds sufficient to obtain Rs. 9,719 for works and to pay yearly interest of Rs. 1,157.

Diagram VII.—Scheme.

The local authority would have to raise initially a loan on the security of their general funds sufficient to obtain Rs. 19,334 for works and to pay interest on Rs. 14,952.

5. The suggested method of credit and debit is capable of considerable extension. Into the ledger account of a holder can be entered not only his contribution towards expenses, and any amount creditable or debitable to him by reason of a rearrangement of his plot, but also any sum awarded by the arbitrator as being payable to him or leviable from him. For example, an agricultural lease might be extinguished and the lessee in consequence would have to be compensated. The portion of such compensation payable by the holder could be paid by the local authority and debited to the holder in his ledger account. In this way the party claiming relief is compensated at once, whilst the holder is given easy terms for repaying the local authority the cost of the advance.

The local authority responsible for carrying out a scheme should be a municipality within its own limits and the local board elsewhere. The controlling authority might be the Commissioner of the Division or even the local Government.

The procedure to introduce a scheme might be briefly as follows:—The local authority will publish a notification in the Government Gazette of its intention to plan a certain area defined by boundaries on the existing survey maps. The existing and proposed main roads will also be shown. The owners will be fully consulted as to accommodation roads, and as to any rearrangement of plots that may be necessary, and the local authority will then prepare and notify a block plan and scheme showing these details, and objections to the same from persons interested will be invited. After considering such objections and making such alterations as it deems necessary, the local authority will submit the scheme and objections received, to the controlling authority for decision and thereupon an independent arbitrator will be appointed to draw up the final scheme and plan as so sanctioned. The arbitrator will be an expert valuer and his duty will consist of making valuations of holdings as already described in this note and demarcate the roads and holdings as finally sanctioned. He will also award the compensation payable for the extinction or transference of any rights or of any property injuriously affected, and will calculate the dues leviable from each holder in accordance with his valuations. He will communicate his decisions to the local authority who will then notify the final scheme and plan and state on which date it will take effect.

6. *Effect of redistribution on legal rights.*

If an owner's plot is altered in shape or size or is actually transferred from one place to another, it is necessary to consider what effect this will have on the lessee or mortgagee of the original plot. As far as possible these rights

should be transferred in the same or a convenient modified form to the new plots, and compensation must be paid to anyone injuriously affected thereby. Agricultural leases should not be transferred without the consent of all parties to the lease, for the object of the scheme is to encourage building operations and to allow the owner, who pays the 'betterment,' every chance of making as much profit as he can out of the land. If a holder and a mortgagee come to terms privately in respect of their rights in the rearranged plot, such an agreement should always be accepted unless its terms are prejudicial to the objects of planning.

The arbitrator appointed to value the lands will also decide questions of compensation for transference of rights, and also decide what rights shall be transferred to the rearranged plots, and on the day that the scheme takes effect the old rights will be extinguished and the new rights will take effect. The common encumbrances on a plot are leases and mortgages and the following examples will show how such cases can be treated and how the apportionment of expenses can be made.

Leases.

If a lease is extinguished or modified it is clear that compensation must be paid to the lessee, and it is for the arbitrator to determine the proportions of such compensation payable by the holder and the local authority, respectively. When a portion of a plot leased for agricultural purposes is taken for a public road under the provisions of the Land Acquisition Act, the tenant generally retains his right on the remainder of the plot. Now as the price of land rises on the construction of a road, it will generally pay the plot holder to get rid of his tenant and utilize or sell his land for building purposes. In order to do this, the owner would have to pay out the tenant at his own expense. If therefore a Town Planning Act gets this done for him it is only fair that he should be debited with its cost.

Example.—A is the owner of 1 acre of homogeneous cultivable land leased to B at a yearly rental of Rs. 60 and the lease has 5 years to run. Under a Town Planning scheme one-tenth of an acre may be required for road purposes and the lease must be extinguished. The compensation payable to B should be borne by the local authority and the holder in the proportion of 1 to 9.

Mortgage without possession.

If the value of a plot as finally rearranged with reference to the improvements contemplated is of greater value than the original plot mortgaged, then the mortgage can be transferred without loss of security. If a scheme is to be successful this will usually be the case. It may happen however that the rearranged plot is less in value than the original plot. If the mortgagee accepts the final plot as his new security then all is well, but if he does not then the whole or any part of the difference in value between the original and the final plot (values as undeveloped) instead of being credited to the holder could be paid to the mortgagee in whole or part satisfaction of the mortgage.

Example.

	Rs.
(*a*) Value of original plot	300
(*b*) Amount due on mortgage	200
(*c*) Undeveloped value of allotted plot	100

Instead of crediting the holder with Rs. 200, *i.e.*, (a-c) for his actual loss of land, it might be paid to the mortgagee and the mortgage redeemed, or the holder might be credited with Rs. 100 and the mortgagee given Rs. 100 and his mortgage transferred to the new plot.

Mortgage with possession.

These are usually either one or other of the following kinds :—

(*a*) the use of the land is given to the mortgagee for a certain number of years in full repayment of the mortgage.

(*b*) The mortgagee holds the land and reaps the profits on it by way of interest on his loan.

Case (*a*) is precisely similar to a lease by the mortgagor to the mortgagee for a definite number of years and can be treated in the same way.

Case (*b*). The mortgagee will be satisfied if he gets at least equal security and an equivalent for the secured profits. Equal security can be arranged as in the case of mortgage without possession, but the mortgagee may not in all cases be able to utilize the allotted plot so as to secure the same profits as the original plot yielded. For any such loss of profits he is entitled to some equivalent at mortgagor's cost and for any increase of profits the mortgagor is entitled to credit. A rocky piece of ground allotted in lieu of a cultivable plot will not always be of use to a mortgagee in possession, for even if the mortgagor consents to the mortgagee erecting buildings on the rocky land, it may not pay the mortgagee to erect a substantial structure and the scheme may not permit of huts being erected. The best course in such a case would be to compensate the mortgagee at the mortgagor's expense for loss of possession and to convert the mortgage with possession into a mortgage without possession. Any amount paid to the mortgagee would go in part satisfaction of the mortgage.

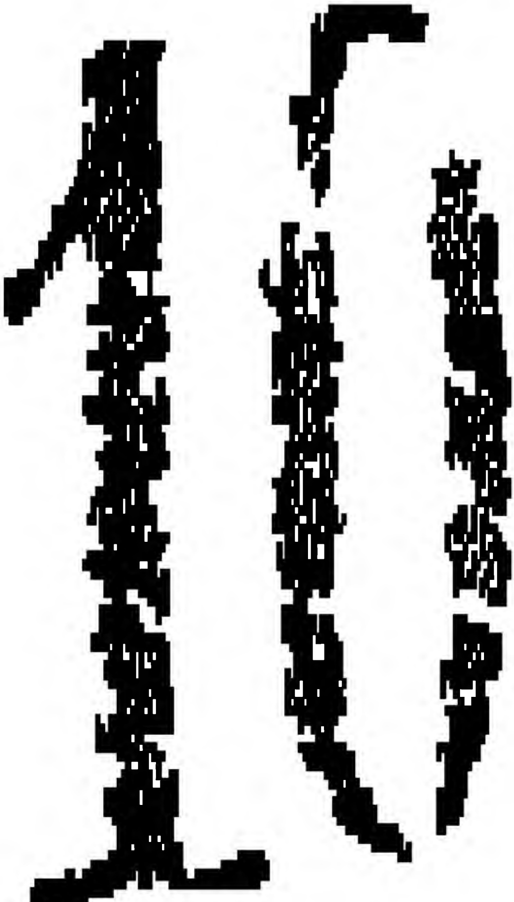
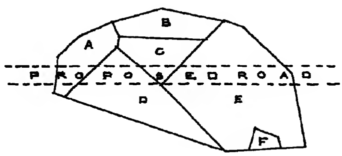


DIAGRAM No. I

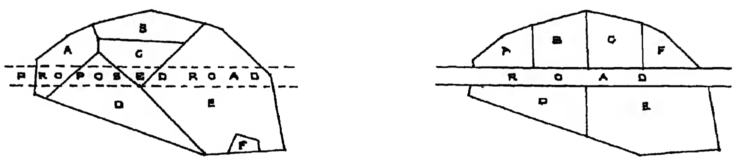
BEFORE REARRANGEMENT AFTER REARRANGEMENT

DIAGRAM No. II



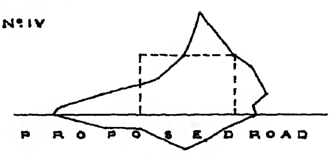
BEFORE REARRANGEMENT AFTER REARRANGEMENT.

DIAGRAM No. III



BEFORE REARRANGEMENT. AFTER REARRANGEMENT.

DIAGRAM No. IV

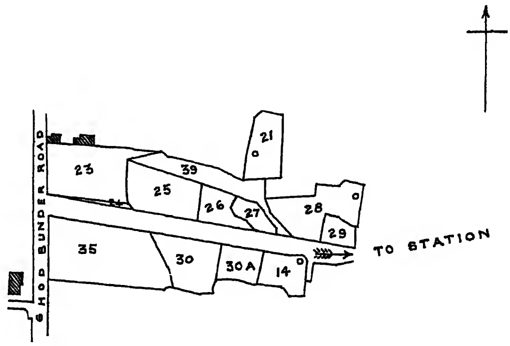


VALUE OF ORIGINAL PLOT 800 Rs
VALUE OF FINAL PLOT 700 Rs.
VALUE OF FINAL PLOT AFTER
CONSTRUCTION OF ROAD 1500 Rs.
OWNER'S LIABILITY $(-100+\frac{1}{2}\times 800)=300$ Rs.

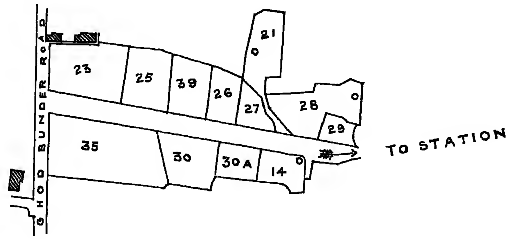
DIAGRAM No. V

SCHEME No. 1 SANTACRUZ

SCALE 330'=1"



BEFORE REARRANGEMENT.

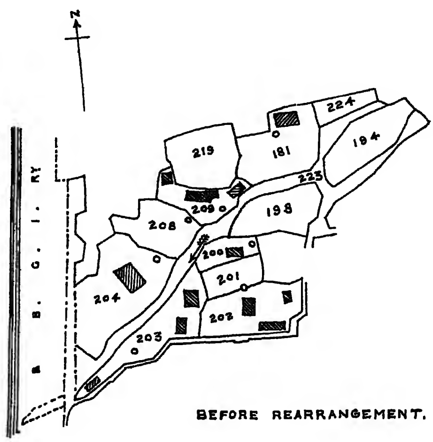


AFTER REARRANGEMENT.

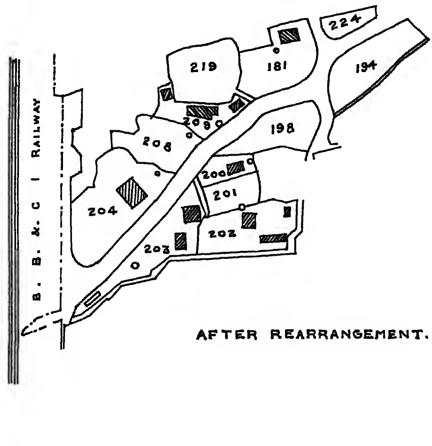
DIAGRAM N° VI

SCHEME N° I VILEPARLE

SCALE 320 FEET TO ONE INCH.



BEFORE REARRANGEMENT.

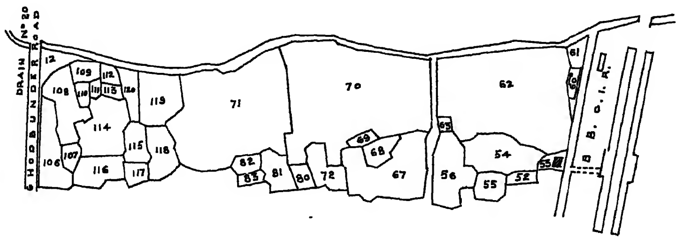


AFTER REARRANGEMENT.

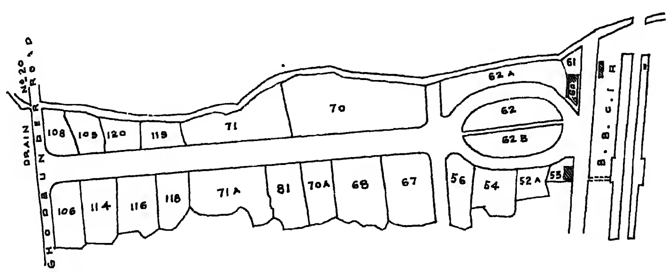
DIAGRAM Nº VII

SCHEME Nº 2 VILEPARLE

SCALE 330 FEET TO ONE INCH



BEFORE REARANGEMENT



AFTER REARRANGEMENT.

LIGHT AND AIR

IN

DWELLINGS IN BOMBAY.

A lecture delivered before the Bombay Sanitary Association

BY

THE HON'BLE MR. J. P. ORR, C.S.I., I.C.S.,

Chairman of the Bombay City Improvement Trust,

on 27th JUNE 1912.

BOMBAY:
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Bombay Improvement Trust.

LIGHT AND AIR IN DWELLINGS IN BOMBAY.

1. Over two years' study of Bombay's slums has gradually brought me to the firm conviction that the two features which contribute most to the insanitary condition of Bombay are— Chief insanitary features of Bombay

(1) the existence in certain quarters of numerous breeding places for malaria—bearing mosquitoes ;

(2) the fact that a large proportion of the poorer classes live in rooms that are insufficiently lighted and ventilated.

At the instance of Government, the Corporation are planning a campaign against mosquito breeding places in the light of the excellent report on the subject published by Dr. Bentley. But, if any substantial improvement is to be made in the sanitary condition of Bombay in the near future, there must, I am convinced, be carried on simultaneously a vigorous campaign against ill-lighted and ill-ventilated living rooms ; and the sooner this campaign is started the better. I assume that my audience being well-acquainted with Bombay do not need to hear a detailed description of the typical cases we have to deal with ; so I have relegated that description to Appendix A which strangers to Bombay into whose hands this lecture may fall will do well to read at this stage.

2. In general terms, the most obvious lines to adopt in a campaign against ill-lighted and ill-ventilated dwelling rooms will be— Wholesale demolition an impracticable remedy on account of its costliness

(1) to wipe such rooms out of existence, and

(2.) to prevent any more from coming into existence.

The Improvement Trust have already done a great deal towards wiping insanitary rooms out of existence by the wholesale demolition of houses in such insanitary areas as Nagpada, Mandvi and the neighbourhoods through which the Princess Street and Sandhurst Roads have been driven. But it is now realised that campaigns conducted on the lines of such whole-

sale demolition are extremely expensive, and, where demolition has been too rapid, have resulted in the increase of overcrowding in the immediate neighbourhood. If this has been so in the small areas which the Trust have hitherto dealt with much more will it be so, if the campaign is extended to all houses which contain ill-lighted and ill-ventilated rooms.

Light and air defective not in front rooms but in back and side rooms.

3. Section 349B of the Bombay City Municipal Act limits the height of houses along a street to the breadth of that street or, in the case of narrow streets, to 40′ or $1\frac{1}{2}$ times the breadth of the street whichever is less. This device for securing that *streets* shall be amply lighted and ventilated has also the excellent effect of ensuring that all *front rooms* in the houses along the street are sufficiently lighted and ventilated. **But the trouble is that hitherto Municipal by-laws have not been directed towards ensuring that back-rooms and side-rooms are sufficiently lighted and ventilated, while the Act itself contains no provision on this point. The result is that the great majority of one-room tenements abutting on the sides or backs of houses in Bombay are grossly defective in light and ventilation.** It nevertheless remains the fact that almost every house has, at any rate, *some* rooms sufficiently lighted and ventilated, and therefore the wholesale demolition method, besides being financially impracticable, involves demolition of so many sanitary rooms as to be in my opinion wholly unjustifiable, unless such demolition is necessary as in the case of Princess Street and Sandhurst Road, for the purpose of driving a ventilation shaft through a congested area or of improving communications in the City. It may be admitted that the wholesale demolition method has done more good than harm; but the nett gain has been achieved at extremely heavy cost and has therefore necessarily been confined to only a small portion of the area requiring sanitary improvement. Municipalities in England and elsewhere have had precisely the same experience, and, like them, we must seek less expensive methods of attacking the first of the problems stated in para. 2, *viz.*, how to wipe insanitary rooms out of existence. Unfortunately, the Municipal Act does not authorise the condemnation of particular rooms or *parts* of houses as unfit for human habitation; only

Wholesale demolition method is generally unjustifiable so far as it involves demolition of front rooms.

Therefore a less expensive method is required.

whole houses can be so condemned under Section 378 : so although the Health Officer agrees with me that people ought not to be allowed to live a single day longer in any of the grossly insanitary dens which we have inspected together, he is unable to take any action in the matter. The remedy in the case of existing houses clearly is to invest some local authority with power to prohibit the use of insanitary rooms for human habitation.

4. Our second problem—how to prevent more insanitary dwelling rooms from coming into existence—can never be solved so long as the Municipal Act and Bye-laws remain as they are. On the contrary, matters must continue to go from bad to worse, as they have long been doing. A detailed explanation of what is wrong with the Municipal Act and Bye-laws is given in Appendix B. **Roughly, the main defects in the Municipal Act and bye-laws are :—**

We cannot check the continuous increase of insanitary rooms so long as Municipal Act and Bye-laws remain as they are.

(1) That they do not provide for there being outside each room sufficient air space free of buildings and open to the sky for the lighting and ventilation of that room, and

(2) that they do not limit the depth of a room in proportion to the area of openings for light and ventilation,

Main defects in Municipal Act and Bye-laws.

Vide Appendix D, clauses 2 & 3.

the result being that only the part of the room nearest the window is lighted and that often the other part is divided (after the completion of the building, when there is no fear of detection by the Municipal staff) into two or three compartments, each let out as a separate tenement, though absolutely unfit for human habitation. Moreover, there is nothing in the Municipal Act or bye-laws requiring a house-owner to limit the height of his house in consideration of the extent to which the height interferes with the lighting and ventilation of the house itself or of houses adjacent to it. All over Bombay, but especially in crowded parts, new storeys are being added to buildings which are already so high as to shut out light and air from the lower rooms of neighbouring houses to a very serious extent. This growing evil is annually adding largely to the number of

Vide Appendix D, clause 3.

insanitary one-room tenements in Bombay, and there is no way of checking it except by special legislation. The improvements made by the Improvement Trust in the few small sections of the City which they have been able to tackle are as a drop in the ocean to the rapid advance in insanitary conditions which is going on all over the City by virtue of the want of some check on extensions of buildings outwards and upwards and the consequent steady deterioration of the already defective lighting and ventilation of the quarters inhabited by the poorer classes of the population. Laudable efforts are being made to relieve sufferers from tuberculosis by providing hospitals and sanitaria for them; but that strikes me as attacking the problem at the wrong end. Far better go to the root of the matter and make hospitals and sanitaria unnecessary by first preventing people from living in the dark foul dens which serve as foci for the propagation of tuberculosis and other diseases and then wiping out some of these dens in order to convert the others into healthy residences by the admission of the two great healing powers that nature supplies gratis,—light and air.

Remedy proposed. Veto occupation of rooms with light and ventilation not up to standard.

Vide Appendix D, clauses 4 & 7

5. **The remedy I propose for the serious evil which I am trying to show up, viz., the existence in Bombay of large and daily increasing numbers of one-room tenements, which for want of adequate lighting and ventilation are, strictly, unfit for human habitation, is to veto the occupation of such rooms under penalty of heavy fine such penalty being exacted not only from the occupier but from the owner. This veto should not take effect through bye-laws or through the agency of any specially empowered officer with respect to particular rooms selected by him, but should apply generally as a substantive provision of law to all rooms which fail to reach a prescribed standard of lighting and ventilation.** I claim for this procedure by veto that it is the simplest and most direct method of dealing with the evils we have to grapple with and that it supplies a solution for both the problems stated in para. 2, for when residence in existing insanitary rooms is prohibited and prevented, they are practically wiped out of existence *as dwelling rooms*; and no insanitary rooms will come into existence; for whereas during the 10 years that

the Municipality were holding the discussion which ultimately led to the passing of amended (but still, as I have tried to show, seriously defective) building bye-laws in 1910, house-owners were pressing on with their building operations so as to escape the new bye-laws, no man will now deliberately build a house with rooms, the light and ventilation of which fall short of the standard contemplated for general adoption, when he knows that on the legalisation of the veto they will be declared unfit for human habitation and he will get no rent for them and no compensation for having to alter them. *Vide* Appendix D, clause 17.

The proposed veto should be gradually extended to the whole of Bombay within five years.

6. It would cause too great and sudden a dislocation of the conditions of life among the poorer classes in Bombay, if all insufficiently lighted and ill-ventilated tenements were declared unfit for human habitation *at once*. The same results would follow as are justly complained of in connection with the Improvement Trust's earlier schemes, in the execution of which demolition followed too closely upon acquisition. The demand for new lodgings would raise rents enormously, and there would be such a rush on uncondemned dwellings that, though sufficiently lighted and ventilated, they would soon become unfit for human habitation by reason of overcrowding. **In order to allow time for gradual re-distribution of population and for gradual improvement of dwellings now insufficiently lighted and ventilated, the veto should not come into force throughout the City till after the expiry of, say, 5 years.** *Vide* Appendix D, clause 4

Meanwhile Municipal Commissioner and Improvement Trust should gradually apply it to the worst areas finding temporary accommodation for tenants of rooms declared U. H. H.

7. **Meanwhile, the Municipal Commissioner and in "represented" areas the Improvement Trust should have power to apply the veto to the worst cases in the worst localities; but in every case the Commissioner or the Improvement Trust should be required to first give the evicted occupants the refusal of decent accommodation within a mile of the condemned dwellings at the same rents as they paid for the latter.** The Commissioner should be at liberty to delegate this power to the Health Officer, and the Improvement Trust should be at liberty to delegate it to the Chairman. Such a provision would operate to make the process of condemnation and eviction sufficiently slow to obviate hardships to those concerned. The Improve- *Vide* Appendix D. clause 5.

ment Trust now have large Estates on which they can, at very short notice, erect semi-permanent sheds, which are in great favour with the poorer classes ; and they also have many vacant rooms in acquired houses which they need not demolish for some years to come, so that there will be few, if any, places within a mile of which the Commissioner or the Improvement Trust cannot find accommodation for the tenants of the worst lighted and ventilated rooms ; these therefore should be condemned at once. The Commissioner should have the same liberty to commandeer open land for the erection of sheds for this purpose as he has under the Epidemic Diseases Act for the purpose of erecting Health Camps.

Tenants entitled to temporary accommodation only until condemned rooms are rendered habitable.

8. No evicted tenant should be held entitled to the accommodation offered to him by the Commissioner or the Improvement Trust, after his original landlord is ready to take him back ; as fast as condemned rooms are rendered habitable, the original tenants should be displaced from the semi-permanent camps in order to make way for occupants of the next houses to be condemned. In this way, the process of improvement would go on gradually in the worst cases throughout the 5 years, and owners of less seriously defective dwellings which the Commissioner or the Improvement Trust might not condemn under their special powers would see that it would be to their interest to set their houses in order before the veto came into general force throughout Bombay at the end of the 5 years.

The Improvement Trust have now about 500 vacant rooms available in chawls and acquired houses in their Estates south of Lal Bagh for people who may be turned out of condemned rooms. Their vacant rooms north of Lal Bagh are not taken into consideration, as they are too far from the congested areas to be in demand. The Trust could however on demand erect quite 5,000 corrugated iron huts on vacant lands in their southern Estates. There is, therefore, no difficulty about finding accommodation for displaced tenants at present. Probably about 20% of the population of congested areas would have to find new quarters, as the alterations necessary to make their old quarters sanitary would result in reduction of accom-

Cf. para. 22 below.

modation ; but the measures I propose will encourage sanitary building, and the 20% will soon find quarters in the new houses that will be erected on what are now open lands or in the old houses which will be vacated as the development of the Trust's and other owner's Estates in the north of the Island and the proposed Back Bay reclamation take people away from the more densely populated areas.

9. Obviously our first supplementary problem is to fix a standard of light and ventilation with a view to applying the veto to dwellings that fall short of it. **It is very desirable that there should be one standard of light and ventilation all over Bombay, and the standard I propose is that which has long been enforced upon Improvement Trust Estates, and which is also now enforced under Municipal Bye-laws all over Calcutta, and in most of the important towns in England; that standard is commonly known as the 63½° standard. It is explained in detail in Appendix B; roughly, it means this that throughout the length of one side of every living room there shall be external air space open to the sky extending to a distance measured horizontally from the room wall of at least half the height of the top of the opposite house above the floor of the room.** It is called the 63½° rule because the angle at which light from the minimum air space so prescribed will strike the floor is an angle of approximately 63½°, which has a tangent of 2 to 1.

Adopt standard of 63½° rule.

For illustration, *vide* Appendix D para 1.

Thus, if a gully between two houses is only 10′ broad the height of each house above the plinth must be limited to 20,′ if the lowest rooms are to satisfy the 63½° rule ; and if two houses of the maximum height ordinarily allowed in Bombay, *viz*.. 70 are built side by side and have side rooms depending upon the space between the houses for their light and ventilation, then, to satisfy the 63½° rule, that space must be 35′ broad. Until recently such houses could have been built in Bombay with an intervening space of 3′ or even less ;* and even under the new bye-laws the width of this space need not exceed 14′ and, in the case of a new house built on a site on which an existing house abuts, need not exceed 7′ which is far too little to permit of the adequate lighting and ventilation of ground

*** *Vide* S. 348 (*f*) of Bombay Municipal Act. *Vide* Bye-law 41 (1) (*a*).**

floor rooms in abutting buildings 70′ high. Probably one excellent result of the universal adoption of the 63½° rule will be that architects will learn to light houses from back and front only, so that buildings will be continuous along the streets and the abominably insanitary gullies that now exist between adjacent houses will altogether disappear.

Relaxation of the standard where land is costly.

10. It would be unfair and disheartening to the sanitary builder to have *in the same locality* a high standard for new buildings and a low standard for old, if the result would be to give the owners of old properties an unfair advantage over those of new properties in the tenement letting market. But in localities such as the Fort, in which land is very costly and buildings very high and close together, it may be found imperative to lower the standard for both old and new buildings, if the adoption of the 63½° standard would throw such a large number of rooms out of occupation as to make impracticable to find accommodation for the original occupants in the neighbourhood. It is found in Improvement Trust Estates that by building *high* sanitary houses on areas which were previously crowded with *low* houses accommodation can be provided for far more than the original population; but where the original houses were unduly high, there must be some considerable permanent displacement of population, if the new houses are to be adequately lighted and ventilated by the clearance of air spaces between them. **It is of course just in such congested areas that adequate lighting and ventilation is most needed; and therefore no undue lowering of the standard should be countenanced; but I think the 63½° might be raised to 68°, the angle with a tangent of 2½ to 1, in such localities. This is permitted in Calcutta in certain cases, and the Corporation might be empowered to apply it with the sanction of Government to particular areas such as the Fort in Bombay. The effect will be that an open space of 28′ will be allowed instead of 35′ between adjacent buildings each 70′ high.**

Vide Appendix D, clause 1.

Temporary concessions to obviate unreasonably heavy expenditure on existing buildings.

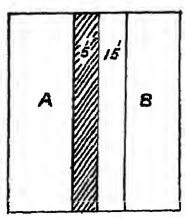
11. Another class of cases large and important enough to receive special consideration consists of cases in which the strict enforcement of the new standard would necessitate heavy expenditure on existing buildings which satisfy the present

Municipal regulations and have only recently been constructed or purchased. **It may be well in such cases to defer the bringing of the lighting and ventilation up to the full $63\frac{1}{2}°$ standard and be content with some lower standard, say, the 68° standard, till the re-construction or substantial alteration of the building is necessary on other grounds (e. g., on the occurrence of a fire) subject to a maximum of, say, 20 years' deferment.** Such a concession might also be made in cases of existing buildings in which the actual lighting and ventilation fall only a little short of standard, *e. g.*, when the space between two chawls each 40′ high is 15′ instead of 20′. But in all such cases the owner should do something to earn the concession ; and one useful condition will be that he should bind himself to remove buildings from a certain area at the end of the concession period. On his executing such a bond, he should be granted exemption from the veto of occupation of the rooms concerned for so long as they remain unaltered, subject to a maximum exemption period of 20 years.

Vide Appendix D, clauses 8 and 15.

Temporary concession in case of new buildings adjacent to old.

12. It will facilitate and expedite the realisation of the improvements we desire, if similar concessions on similar conditions are made in such cases as that illustrated in the margin. B wants to build a chawl 40′ high on a vacant plot next to an existing chawl which A has recently built 40′ high over every inch of his land. B must leave a 20′ margin in his land, and to prevent A benefiting thereby can erect a hoarding along the common boundary which will result in many of the rooms in A's chawl being condemned as unfit for human habitation. To escape this, A must demolish 20′ of his chawl, unless he can make terms with B for both to share B's 20′ strip ; but if B leaves more than a 15′ strip open, he will not have room left to build a chawl on. If the standard is strictly enforced, A will have to pull down 5′ of his newly constructed building and rearrange the remainder at prohibitive expense. In such a case A and B should be required to enter into an undertaking that a strip 15′ broad shall be always kept vacant on B's side of the boundary and that when A's chawl is rebuilt or at most 20 years hence A shall clear a strip of 5′ along his side. Thereupon B should be allowed to build along the 15′ margin, the breach of standard being condoned for at most 20 years.



Vide Appendix D, clauses 8 and 15.

Temporary concessions to be granted by Special Committee after personal investigation by selected Officers of high standing.

13. There will be numerous other smaller classes of cases in which the making of concessions will be justified by the desirability of getting the requisite improvements made gradually in order to reduce the hardship the innovation may cause to a minimum; **but in order that there may be a consistent policy in this matter, it seems very necessary that such concessions should be subject to some general limitation and should be granted only by a special committee and only at the instance of some officer of high standing, who has previously investigated the case, and not on investigation by mere subordinates. The Special Committee might consist of the Municipal Commissioner, the Chairman, Improvement Trust, and Health Officer, and they might act on their own investigations or on those of the Deputy Health Officer, Executive Engineer and Deputy Engineer of the Municipality and the Engineer and Land Manager of the Improvement Trust and their Deputies.** They will learn by experience in investigation of actual cases what are the best lines to work on, and it should not be necessary to legislate as to their procedure beyond laying down certain broad limitations within which exemptions from the general veto must be confined. The actual experience I have gained in applying my proposals to the Trust's Estate on Nowroji Hill shows that the commonest class of cases requiring special treatment on their individual merits is that of rooms in irregularly grouped houses, in which, though the * light plane is partially obstructed by a neighbouring house, the deficiency of direct light caused thereby is more than made good by diffused light or by light received obliquely across a low house next to the obstructing house. For such cases no general rule can be framed. The Special Committee must deal with each on its merits.

Vide Appendix D, clauses 4, 8, 14.

Vide Appendix D, clause 1.

For definition of "light-plane," *vide* Appendix D, clause 1

Vide Appendix D, clause 15.

Co-operation between neighbours necessary so that each may benefit by open space in the property of the others.

14. The difficulty about complying with the $63\frac{1}{2}^\circ$ rule is that to secure full value from any site the owner has to make an agreement with his neighbour by which each may share the advantages of the open space provided on his neighbour's site. It would be wasteful of space for a man who wants to build a building 40′ high to provide 20′ of open space *on his own site*: he can make the most of his site by leaving a space of 10′ open and getting his neighbour to leave a similar space open alongside of it. This can be easily arranged on large estates like those of the improvement Trust, where buildings on adjacent plots are controlled by the same landlord; and where vacant building sites of regular outline adjoin one another, owners will generally come to an agreement as to what open margin should be left along the common border; but where irregular

building sites, some built upon, some yet to be built on, all in different ownership, lie higgledy-piggledy in juxtaposition, many difficulties present themselves, especially if neighbours are not on good terms with one another; and after studying many such cases, I have come to the conclusion that the best way to deal with them is to use the lever supplied by veto of occupation of rooms that do not comply with the 63½° rule as a means of inducing neighbours to come to an early agreement mutually beneficial to all concerned. Bombay Architects have now gained sufficient experience of the practical working of the 63½° rule to be able to show their clients how in co-operation with their neighbours and at the least expense and with the least loss of time to design new buildings or make the structural alterations necessary to give old insanitary buildings as large as possible a number of rooms complying with the 63½° standard. It will be to owners' interest to carry out these alterations quickly, in order to get their tenants back again and so secure rent.

15. In the numerous actual cases which I have investigated with a view to testing the practicability of my proposals as regards sanitary reconstruction of existing houses I have found many in which a difficulty arises from the fact that the house is so small and so shut in by other houses that the admission of a sufficiency of light and air to the back and side rooms involves demolition of an unduly large proportion of the house and consequently the requisite alterations can only be made at a heavy loss. Such cases, however, generally occur in groups, and it is generally practicable to acquire one of the houses concerned and parcel its site out for the benefit of the others. This will be best understood by a study of the particular instances given in Appendices A and C. **Power to acquire houses, demolish them in whole or part and apportion the cleared site to neighbouring houses either as open space or for extension of the existing buildings (*e.g.*, in order to find a more suitable location for W. Cs. and washing places) should be given to the local authority to use for the assistance and at the instance of owners of decent properties which are spoilt by the juxtaposition of mean insanitary houses which the owners will not sell except on preposterously high terms, if they cannot be dealt with under the Land Acquisition Act. In such cases the cost of acquisition should be recoverable from the properties benefited.**

Local authority should have power to acquire houses in order to form air spaces or room for extension of neighbouring houses requiring sanitary reconstruction.

Vide Appendix D, §9.

Vide Appendix A, Plan B

16. In "represented" areas in which the early provision of dwellings to replace those condemned is a matter of public importance and owners are not taking

Improvement Trust to enforce reconstruction or in case of obstructive houses demolition.

Vide Appendix D, clauses 11 and 12.

up sanitary re-construction work fast enough I would give the Improvement Trust power (1) to acquire any house containing more than 10 rooms condemned as U. H. H. and to so re-construct it, as to make all the living rooms conform to the prescribed standard of lighting and ventilation, in case the owner fails to comply within 12 months with the Trust's requisition calling upon him to do this work himself and (2) to acquire and demolish houses or parts of houses that so obstruct the lighting and ventilation of surrounding houses as to make more than 10 rooms unfit for human habitation according to this prescribed standard.

Vide Appendix D, para. 13.

In many cases owner will probably reconstruct his house and so save the Trust from the loss they are unfairly put to now on acquisition of insanitary dwellings.

17. The Trust have now to pay compensation on the basis of high rents which chawl owners secure only because they are at liberty to overcrowd their sites with insanitary rooms. No chawl owner will comply with a requisition to re-construct, so long as the alternative is to receive compensation *on the basis of these rack rents.* Sanitary dwellings will, of course, pay him a far smaller return than the old insanitary ones; but when he will no longer get a handsome return, as he does now, by re-investing his compensation money in fresh insanitary buildings, he will probably prefer to secure a moderate return by making the necessary alterations of his chawls himself as soon as possible rather than lose the rent of his condemned rooms for a year and then receive compensation based not on his original rack rents, but on the return he can get for the property after spending on it what is required to bring it up to modern standards of sanitation. In cases in which it is impossible for the owner to secure an adequate return upon the expenditure involved in the necessary alterations, it will be a relief to him to have his non-paying property acquired and the loss shifted to the public purse; and since this loss will be incurred in the interest of public health, I see no reason why the Improvement Trust should not undertake it and even pay the owner the usual 15% under Land Acquisition Act, Section 23 (2) on account of the compulsory nature of the acquisition. In cases in which the Trust demolish part of the acquired house, in order to admit light and air to neighbouring houses, the cost to the public purse can be reduced in a way which is not open to the original owner, **if the Trust are empowered, as they should be, to recover a contribution towards the nett cost of acquisition and alteration or demolition of the obstructive property from the owners of the properties benefited by the demolition in proportion to the betterment these properties respectively secure. If any owner is too poor to be able to pay his share of the cost in a lump sum down, 30**

In cases in which reconstruction will not pay the owner, he will be fully compensated and the Trust may be able to make reconstruction or demolition pay by levying betterment rate on neighbouring houses.

Vide Appendix D, clause 10.

annual payments of 6 per cent. on his share may be accepted instead as a betterment rate. This is on the 4 per cent. table just about equivalent to the immediate payment of the lump sum. To save this measure from becoming oppressive to poor house owners, we may perhaps fix a limit beyond which cost of acquisition of houses or parts of houses constructed before, say, June 1912, should be borne by the public purse, *e.g.*, by limiting General Tax plus this annual payment to 25 per cent. of Assessment. *Vide* Appendix D, clause 13.

Some instances of such obstructive buildings are shown in the plans appended in Appendix C, with estimates of the cost of acquiring them and notes as to how the cost will be distributed among the owners of adjacent properties.

How the acquired property is to be disposed of

Vide Appendix D, clause 9.

**Vide* Appendix D, clauses 1 and 2.

18. **The general idea in disposing of an obstructive property acquired by the Trust *suo motu* (V. para. 16 above) is to retain it as Trust property dominated by the right conceded to owners of neighbouring houses to prohibit building above their light* planes. If the property has cost an average of Rs. 50 per square yard to acquire, each owner is charged for this concession half that rate, i.e., Rs. 25 per square yard for the area over which he can prohibit building above his light planes.** This will be understood by study of the instances given in Appendix C. Public hydrants can be conveniently located in these open spaces; and these will immensely increase protection from fire. It is a marvel that there have not been more fires in the many congested areas in the city into which in case of fire, it would be impossible to bring in even a fire hose hand cart. There will often be ample space below the dominating air planes for a ground floor structure not intended for human habitation, and it will be a convenience to the Municipality to be able to build vaccination stations, registration offices, public urinals and W. Cs., stores, chaukis and the like on such sites or use them as metal depôts; and they may even let some for godowns or motor garages; but in most places the sites will remain open, and should be levelled and tarred and planted with trees. They will be invaluable as air spaces and playgrounds for children. A demonstration of their great utility for this purpose is afforded by a visit to such localities as Lower Colaba and Umarkhadi where, in pursuance of cross road schemes laid down years ago, the Municipality have acquired several small spaces under the set-back sections. These spaces are not yet sufficiently continuous to admit of the actual construction of roads; so children safely play in them without any danger from cart traffic. The tarred open spaces between Improvement Trust chawls afford a similar illustration of the utility of these places for children.

Need of open spaces in the City.

A Committee of the Corporation has been sitting nearly 3 years for the purpose of devising methods for securing more open sites in the City, and their tendency is to recommend creation of a very few large recreation grounds at great expense. I venture to think that far more good will result at far less expense from the creation of small ventilation chauks for every small group of houses and from insisting on every house site including some open space for the lighting and ventilation of the house. **Large central recreation grounds are all right for adults who can walk a mile or two to get to them; but it's the little children we want specially to provide for. We want to save them from being brought up in dark places and foul air, while they are too weak to resist the diseases that germinate in such surroundings; and we can't succeed in this unless we go right down to the unit of the single room-tenement and insist on each such dwelling room receiving its full quota of light and air and on each house contributing its share towards an open space provided as an amenity for every small group of houses.**

Recapitulation

19. Let me now recapitulate my proposals :—

I have shown to begin with (paras. 1 to 3) the need of some cheaper substitute for the unjustifiably costly measure of wholesale demolition as a remedy for the evils resulting from the existence of large numbers of ill-lighted and ill-ventilated one room tenements in Bombay (Appendix A).

I have shown (para. 4 and Appendix B) what are the main defects in the Municipal Act and bye-laws by reason of which the number of such insanitary rooms increases from year to year.

I have proposed (paras. 5 and 9) as the first step towards mending matters legislation prohibiting the use for human habitation of rooms that fail to satisfy the 63½° standard of lighting and ventilation, such prohibition to apply generally all over the City after 5 years (para. 6) but to be meanwhile applied (para. 7) to the worst rooms in specially insanitary areas, temporary accommodation being offered (para. 8) to the tenants, till the landlords have rendered their rooms fit for human habitation.

I have shown how, to make matters easier for house-owners and landlords, the 63½° standard may be locally (para. 10) or temporarily (paras. 11 and 12) relaxed by a Special Committee of high officers appointed to investigate individual cases (para. 13).

I have explained (para. 14) how house-owners can reduce the difficulty of complying with the $63\frac{1}{2}^{\circ}$ rule by co-operation with their neighbours and suggested (para. 15) that where a co-operative improvement scheme is likely to be spoilt by the recalcitrance of a minority, the Improvement Trust should be empowered to acquire obstructive properties at the instance and for the benefit of the majority and at their expense.

I have suggested (para. 16) that where reconstruction by owners is not proceeding fast enough the Improvement Trust should have power to acquire and reconstruct defective houses and also power to acquire and demolish obstructive houses (para. 17) and charge a limited betterment rate on the houses benefited by such demolition; and finally I have shown how the sites thus acquired may be used (para. 18) to meet the need of open spaces in the City.

Inspection of condemned rooms.

20. It has been suggested that the Municipality will have to keep a huge staff of inspectors in order to ensure that condemned rooms are not surreptitiously occupied ; and it is represented that the people of Bombay rightly resent the intrusion of low-paid subordinates into their houses for inspection purposes ; but this will not be necessary if the alternative is adopted of attaching a very severe penalty of both fine and imprisonment to occupiers of condemned dwellings, together with liability to demolition in extreme cases. **If the penalty is made severe enough and rent charged for condemned rooms is declared irrecoverable at law, it should be unnecessary to give power of entry for inspection of condemned rooms to more than the members of the Special Committee and the investigating officers mentioned in para. 13.**

Vide Appendix D, para. 17.

Result of applying proposed measures to Nowroji Hill Estate.

21. After writing the first draft of this lecture I deferred delivering it, in order to test the practicability of my suggestions by actually applying them to the one big insanitary area of which I had control, *viz.*, the Nowroji Hill Estate, on which about 350 houses have been acquired by the Trust. Many of these houses were rickety and had to be demolished at once ; but instead of demolishing the remainder soon after acquisition the Trust have retained most of them in the occupation of the tenants of the original owners.

In the last six months a thorough inspection of every room in the Estate has been made. Rooms have been classified as fit or unfit for human habitation ; those condemned as unfit have been vacated and closed, except such as could be rendered

habitable by structural changes or by the removal of obstructive houses that were keeping light and air out of them.

As practically all the houses on this Estate must, in the course of a few years, be demolished in order to permit of the quarrying of the stone in the hill and the laying out of the new Estate, it was not worth while to incur great expense on structural alterations; but wherever a house or group of houses containing many condemned rooms was found, a decision was made on the spot, as to whether one or more of the houses should be removed to form ventilation chauks, or whether condemned rooms should simply be vacated and closed. **The result can be seen upon the model of the Estate in the Trust Office or, better still, by a visit to the spot. Since November 11th, 22 houses have been demolished, and any body can see how immensely the light and ventilation of the neighbouring houses have been improved thereby, as also by the previous demolitions. The 22 houses demolished since November 11th contained 39 condemned and 224 approved rooms occupied and vacant. All the occupants had one month's notice to quit, and accommodation was offered to them in the vacant approved rooms on the Trust Estate. About half of them accepted the accommodation offered ; the others preferred accommodation elsewhere in view of the prospect of their being turned out of Nowroji Hill a few years hence. There remain on the Estate 279 houses containing 4,405 rooms rented at Rs. 24,357 per mensem, 410 vacant rooms fit for human habitation and rentable at Rs. 2,180 and 329 condemned rooms originally rented at Rs. 1,132 but now all vacated.**

From the results on Nowroji Hill it may be deduced that new houses are required with accommodation sufficient for 20 per cent. of the population of congested areas.

22. The Nowroji Hill Estate is fairly typical of the badly congested areas in the City, and the results of our sanitary survey may therefore be taken as a guide to show how far accommodation in similar areas will be affected by the operations I have suggested. **Out of the 5,407 rooms on the Estate, 368 had to be condemned and 224 not condemned had to be vacated in order that the houses containing them might be demolished for the improvement of neighbouring houses. The accommodation on the Estate has thus been reduced by about 11 per cent.** Some houses had already been demolished before November as dangerously rickety, and their demolition improved certain rooms which would otherwise have been condemned ; moreover a good many of the approved rooms would probably be condemned if the classification had been made strictly according to my proposals. On the other hand in considering reduction of

accommodation, no account has been taken of increased accommodation made possible by liberty to add new storeys to buildings in the neighbourhood of newly-created open spaces (Cf. Appx. A. para. 15). **We are therefore absolutely on the safe side in putting the reduction of accommodation due to the measures I have suggested for general adoption at 20 per cent. (vide para. 8 above); and I am confident that, if the redistribution of 20 per cent. of the population of the most congested areas in the City is spread over 5 years, there will be no serious difficulty in the matter.** Luckily for Bombay the period of most serious congestion is in the fair weather (December to May) when large numbers of labourers come up from the Mofussil, and the congestion is relieved then by the people's habit of sleeping out in the open.

Owners will probably co-operate to set their houses in order under pressure of the veto.

23. It was of course far easier for the Trust to deal with their houses on Nowroji Hill Estate than it would be for the owners of single houses who may not be able to get their neighbours to make plans for improvement of their properties that would fit in with their own. But I believe that the difficulties that such owners will undoubtedly have will be greatly mitigated by the legislative measures that I have proposed, and that when the owners see that, by virtue of the operation of the veto, it is only by co-operation with their neighbours that they will be able to get their condemned rooms tenanted again by bringing their light and ventilation up to the required standard, they will quickly take advantage of the facilities offered to them to set their houses in order.

Opposition to veto expected from house-owners of congested areas.

24. I am well aware that my main proposal—to use the power of veto as a lever—is one which is bound to provoke the most strenuous opposition at the hands of the bulk of the owners of houses situated in the more congested parts of Bombay; for the object of the campaign is to wipe out of existence all insufficiently lighted and ventilated dwellings in Bombay, and these include a large number which have long been a source of big profits to their landlords, yielding an annual return which must, in some cases, be greatly decreased in future, if the campaign is successful; but these insanitary dwellings are a standing menace to the public health, their number is increasing every year and their removal or conversion into sanitary dwellings cannot but effect a great improvement in the health and comfort of the poorer classes who have been compelled by force of circumstances to occupy them hitherto. The campaign is therefore in an excellent cause, and no public spirited man who has any regard for the health and comfort of his poorer fellow citizens will shrink from facing the opposition, however violent it may be. Indeed I am not without hope, seeing signs

in various quarters (*e. g.*, the creation of this Sanitary Association) of the growth of what I may call a public sanitary conscience in Bombay, that even some of the landlords whose pockets will be affected, if the campaign is successful, will rather support the campaign than continue to bear the reproach that they care too much for ill-gotten private gains and too little for the health and well-being of their fellow-citizens in this great City.

Legislation required.

25. I append as Appendix D a very rough draft of the legislative provisions required to give effect to the policy I am advocating. I have made no attempt to put them into exact legal language, so they will have to be knocked into shape by a lawyer; but they will give the reader a rough general idea of the kind of legal procedure contemplated in my suggestions.

Conclusion.

26. **The more I think this matter over and the more I see of the numerous building operations that are making the lighting and ventilation of dwellings in Bombay worse and worse from day to day, the more firmly am I convinced that the proper remedy is the power to veto occupation of ill-lighted and ill-ventilated dwellings; and the more strongly do I feel that legislation conferring that power on the Municipal Commissioner and the Improvement Trust and prescribing the 63½° standard for general adoption ought to be undertaken without further delay.**

J. P. ORR,

Chairman,

BOMBAY CITY IMPROVEMENT TRUST.

1*st June* 1912.

APPENDIX A.

TYPICAL INSTANCES OF ILL-LIGHTED AND ILL-VENTILATED ROOMS IN BOMBAY WITH SUGGESTIONS FOR THEIR IMPROVEMENT.

An unobservant stranger driving through the main streets of Bombay may form the opinion that there is nothing very wrong in the lighting and ventilation of Bombay houses; but he must leave the main streets and walk into the side streets and gullies and the deep houses running back from them in order to get an idea of the conditions under which the poorer classes of the community live. Front rooms are mostly well lighted and ventilated, but a very large proportion of back-rooms and side-rooms on all but the topmost floors are grossly insanitary from various causes, but chiefly through defective lighting and ventilation.

2. Two of the commonest types of insanitary houses are described in the following notes:—

(1) Those which run deep back from a street and have their back-rooms lighted and ventilated only through side spaces between them and the nearest houses, such spaces being often only 2′ or 3′ wide with eaves projecting over them and almost meeting and foul smelling gutters running down their whole length to receive rain water from the roofs and sullage from washing places and the overflow of urine from privies.

(2) Undetached houses situated in a continuous line between two parallel streets and separated by a gully 2′ or 3′ wide midway between the two streets with privies and washing places abutting on it and all the characteristics of the gullies in class (1).

3. Houses Nos. 66-78 in Umarkhadi Road, of which a plan (A) is attached, are good specimens of class (1):—House No. 66-68 consisting of ground floor and three upper storeys has not been enlarged or improved during the last 10 years. It contains 48 one-room tenements, of which 30, though occupied, are unfit for human habitation.

House No. 70-72, originally consisted of ground floor, two upper storeys and a loft. It was marked U. H. H. on 3rd January 1904. The loft was then removed and the house repaired, improved and occupied on 25th October 1904. The house now consists of ground and two upper floors. This house contains 48 rooms, of which 26, though inhabited, are strictly unfit for human habitation.

House No. 74-76, originally formed two houses, the front and the rear with a space between. Both these houses consisted of ground floor, first floor and a loft. There were six rooms in the front house and five rooms in the rear. In 1902 these two houses were repaired, enlarged and converted into one continuous chawl consisting of ground and two upper floors with 10 rooms on each of 3 floors, and they were occupied on 20th December 1903. Thus, the original 11 rooms have been increased to 30, of which 18, though occupied, are strictly unfit for human habitation.

House No. 78 consisted of only 12 rooms on each of 3 floors up to 10th October 1910. The revised Municipal Bye-laws came into force on 24th March 1910. The new building contravenes them in many respects. The plans were submitted to the Municipality on 12th February 1910 and passed on 1st March; but work was not commenced till 10th October. The house was then enlarged by an addition of 8 rooms on each of 3 floors in the rear, on what had till then been an open compound. The enlarged house was completed on 19th May 1911 and partly occupied on 25th May 1911. The original 36 rooms were increased to 60, of which 34, though occupied, are strictly unfit for human habitation.

In classifying rooms as U. H. H. the 63½° standard has not been followed; otherwise several of the top floor rooms would have to be condemned. The rooms condemned comprise all except front rooms, top floor rooms and the rooms abutting on chowks on the top floor but one.

4. The mere perusal of these notes and study of the plan attached and of the model of these four houses on view in the Improvement Trust Office cannot give the reader an adequate idea of the sad conditions of life in these 4 chawls; to fully appreciate them he should visit the chawls and inspect each room. The internal passages, even in bright weather, are so dark that one stumbles over children squatting in them. The external gullies are so foul smelling that one is not surprised to find the windows opening into them all shut. One hears sounds and, lighting a match, sees on the walls and floors signs of spitting which show how tuberculosis is spread in these dark foul dens. And yet these chawls have been built so as (just) not to break any provisions of the Municipal Act and old bye-laws; and that they are at any rate up to the average of chawls in the neighbourhood may be gathered from the fact that the owners are able to keep them occupied at rents varying from Rs. 3-8 to Rs. 5 per room per month.

5. **The irony of the situation lies in the fact that these houses are included in a scheme for improvement of an area represented in 1905 under Section 24 (2) of the City of Bombay Improvement Act as grossly insanitary and as requiring to be dealt with by the wholesale demolition method; that within the last 8 years their owners have under pressure from the Health Department "improved" them; that in two cases the opportunity was at the same time taken to enlarge them considerably by building over every bit of what was previously the compound; that in all cases the rents have been increased; and that consequently the cost of acquiring them must be far greater now than at the time of the original representation. Meanwhile, the owners have been making far greater profits than they could have made, had they been forced to keep a sufficiency of open spaces round the houses in the interest of public health; and, therefore, in my opinion the appropriate way of dealing with them is not to pay them compensation based on those abnormal profits, but to require them to devote part of their profits towards cutting out some of their rooms in order to make the others fit for human habitation in future.**

6. Of the second class of cases a good specimen is provided in the small section of 2nd Nagpada shown in the appended plan B. It is obvious from a glance at the survey sheets of Bombay that there were large areas deliberately laid out at some time for building purposes in Nagpada,

Kamatipura, Memonwada and other districts North of Pydhoni, and the explanation is that, these parts constituted what are shown in the old "Foras" maps as "Old Town" and "New Town," the localities in which building sites were given to people who were turned out of the zones which were at different times cleared of buildings in connection with military plans for the defence of the Fort. As the range of cannon increased, the zone was broadened in 1739 to 400 yards and in 1803 to 800 yards measured from the Fort wall and the people evicted were allowed to take up building sites in Old Town and New Town on those two occasions respectively. The New Town was also the refuge of many Konkanis who lost their property in the Fort in the great fire of 1803.

7. The Town planners of those days were liberal enough—in fact over liberal—with their roads, and their plan evidently was to form rectangles between 4 roads, divide them into two by a transverse gully just big enough to let a sweeper get to the privies abutting on it, and form house sites of equal depth on either side, with any breadth the builder might choose. Unfortunately, they put no limit on the proportion of each site that might be built on or on the breadth of each site and most of the occupants have, in course of time, built over the whole site, while breadth of 7′ to 10′ are quite common. Only a visit to the site can give an idea of the insanitary conditions resulting from consequential want of light and air in back rooms and the poverty and squalor of the bulk of the houses, inhabited as most are by the poorest and most ignorant tenants. Nevertheless the original conditions have not only been allowed to continue under the Municipal Act and Bye-laws, but owners are allowed to build over the whole of their old plinths when they do any reconstruction work and many have added one and even two storeys to their original houses, so that the lighting and ventilation of their lower back rooms and of those of the adjacent houses have become far worse than before.

8. This state of affairs is found not only in Old Town and New Town, but, as a glance at the survey plans will show, in large areas all over the City, differing from the Old Town and New Town only in that the house sites have not been so regularly laid out, so that there are many bends and awkward corners in the intermediate gullies which are consequently in an even more hopelessly insanitary condition than those of Nagpada, and must be a most dangerous source of infection to all who live in the dark rooms which abut on them.

SUGGESTIONS FOR IMPROVEMENT.

9. If to the two types of house-groups described above we add the variations due to the addition of a higgledy-piggledy arrangement of houses, or low plinths, or water-logged surroundings, we shall probably include in these types and their variations the bulk of the insanitary houses of Bombay, and I maintain that most of them can be improved out of all knowledge by such devices for admitting light and air as partial

demolition and reconstruction directed towards converting the narrow, dark, foul gullies into open spaces sufficiently wide to admit of the lighting and ventilation of the adjoining rooms in accordance with the 63½° standard.

10. That the necessity of some such measure has already been realised by the Corporation is evident from the amendments recently made (after several years' discussion) in the building bye-laws, under which the side and back rooms of new buildings are required, if used as dwelling rooms, to have outside them certain air spaces varying from 2′ to 10′ in breadth according to the height of the building; but owners evade these new bye-laws, which are unfortunately so worded as to afford many loopholes for escape. For instance, the spaces are required only outside *living* rooms, so rooms are described in the builders' plans as kitchens, dressing rooms, etc., to escape the bye-laws, and after completion of the building are used as living rooms with impunity. **But my chief objection to the new bye-laws is that they are useless in the areas in which improvement is most required, viz., those already built over, because they do not apply, as the corresponding 63½° rules in Calcutta is rigidly applied, to old buildings when reconstructed or substantially altered, "unless and except to the extent to which" the work in hand contemplates the removal of more than half of a wall measured in superficial area from the plinth upwards or in frame buildings of more than half the posts, a provision which is easily evaded by carrying out reconstruction by instalments.**

11. Little good can ever come of half-hearted measures that only touch the fringe of the subject and leave the root of the evil, the old insanitary buildings untouched, it is worse than useless to have a house here and a house there partially improved, while all round are old houses and gullies that continue to be centres of disease and become more and more dangerous as the houses around them are raised storey by storey.

The remedy to be adopted must be one that goes to the root of the evil and deals promptly and effectively with it wherever it is found.

12. Many of the grossly insanitary rooms which were inspected by Lord Sandhurst and other high officials in 1897 as types of the dwellings of which Bombay was to be purged by the introduction of the City of Bombay Improvement Act are still in existence and *still inhabited.* Many more, equally defective in light and ventilation and only superior to the other ones in construction, have been created without breach of the Municipal Act and Bye-laws since 1897. Further, rooms that were fairly lighted and ventilated in 1897 have had light and air shut out from them by the erection of new buildings or the addition of new storeys to old buildings in their vicinity. Visitors to whom I show such rooms call it a public scandal that human beings should be housed in such places and ask why it is allowed. The reply is that the law gives no one any power to stop it and that the growth of the evil is going on so gradually and in places so shut out from public view that the citizens of Bombay have not realized how urgently an amendment of the law is needed, and so far from clamouring for a law to prevent owners from letting out grossly insanitary rooms for human habitation are inclined to look upon any restriction of an owner's right to build upon his old plinth as confiscation and any interference with a poor man's choice of dwelling place as grand-motherly and tyrannical.

It is interesting to note that it was this same tender-hearted attitude of the public and Government towards house-owners that prevented the laying out of the Fort on sanitary lines after the great fire in 1803. The deplorable consequences of the loss of that opportunity are seen in the Fort to-day; and still more deplorable consequences will ensue if another fire occurs and finds us still unprepared to grapple with the danger to public health that the "sweating" of building sites entails by insisting on every house having ample air space on at least two sides of it so that every dwelling room is adequately lighted and ventilated.

Vide Gazetteer, Vol. II, page 343.

13. **The first step I suggest is a general veto on use of inadequately lighted and ventilated rooms for human habitation. This will stop the use of existing insanitary dwelling rooms and prevent more from coming into existence; and the next step is to actually get those now existing wiped out by requiring their owners to make them sanitary and assisting them by placing at their disposal strips of land acquired and cleared of buildings for the purpose of providing air spaces outside houses in the neighbourhood.**

14. How this can be done in the case of the two typical house groups described in this note is indicated in the attached plans in which the hatched areas indicate those which must be acquired and cleared of buildings and the cross hatched areas those which can then be used for extension of neighbouring buildings in order to provide room for the privies, washing places, etc., that may have been cleared away in order to get the $63\frac{1}{2}^{\circ}$ rule satisfied. There are of course many alternative methods feasible, but those suggested involve less interference with existing buildings than the others, and therefore less displacement of population, which is an important advantage.

15. In the Umarkhadi case (Plan A) omitting the eastern half of house No. 78 which must be improved by demolition of rooms in the next house eastwards, the original 159 rooms will be reduced to 113; but these will be all inhabitable, whereas 92 of the original 159 were U. H. H. and only 67 habitable. Under the new arrangements 21 new rooms can be added to 2 houses, so that there will be 134 habitable rooms, *i.e.*, double the original number.

16. In the Nagpada case (Plan B) the sites containing the narrowest, lowest and meanest houses are proposed for acquisition and will be mostly used as open spaces, but partly also for location of privies and washing places that are to be cleared out of the 20′ strip to which the central gully is to be widened and partly (along the frontages) for extension of neighbouring buildings to compensate them for loss of rear rooms taken into the 15′ strip.

The general idea is to require owners to clear away buildings (in nearly all cases privies and washing places) along the existing gully so as to create an open space at least 20′ broad in place of the 2′ or 3′ gully. In most cases, as will be seen from the instances given in Plan C (which incidentally shows how ill-lighted and ventilated the existing rooms are) the privies can be replaced by W. C's placed in the middle of the house with washing places beside them and a living room on each side, one lighted from the front and the other from the new 20′ space at the rear, which

In Calcutta, *vide* rule 22 on page 27, a space of 40′ (20 in each holding) would be required.

will allow of the houses being raised to a height of 40'. In some cases in which this arrangement is not feasible the back part of an adjacent house can be demolished and on the cleared site W. C's and washing places for the 2 abutting houses can be provided as shown by hatching in Plan B.

The result of the alterations suggested will be to reduce the number of rooms on each narrow site to two and on each broad site to four on each floor; but these will be larger rooms than the original four, six or eight rooms, and will be thoroughly well lighted and ventilated. In the 8 houses shown in Plan C, for instance, the only rooms adequately lighted and ventilated are those in front, those on the top floor, those abutting on chowks on the top floor but one and, in the case of high houses overlooking low houses, a few more rooms in the rear. The result of the proposed alteration will be to provide 76 sanitary rooms where there were previously 124 smaller rooms, including 76 sanitary and 48 insanitary: but further the provision of new open sites in rear will enable some owners to add extra floors to their houses, so that probably the total number of people that can be sanitarily accommodated in the altered houses will not be much below that of the people now housed in the existing grossly insanitary buildings.

Particulars of a block of houses in Umarkhadi Scheme. (Plan A).

Street No.	Existing Arrangement.			Proposed Arrangement.			Remarks
	Sanitary Rooms.	U. H. H. Rooms.	Total No. of Rooms.	Sanitary Rooms.	U. H. H Rooms.	Total No. of Rooms.	
66-68	18	30	48	32	Nil.	32	The 27 rooms in eastern half of No. 78 are not included in this statement. Under the proposed arrangement in addition to securing 113 habitable rooms instead of the existing 67, 17 extra habitable rooms can be added on new floors in Street No. 78 and 70-72, and 4 additional rooms can be constructed in rear of Street No. 70-72. Thus there will be 134 habitable rooms instead of the original 67.
70-72	22	26	48	45	Nil.	45	
74-76	12	18	30	3	Nil.	3	
78 W. half	15	18	33	33	Nil.	33	
Total...	67	92	159	113	0	113	

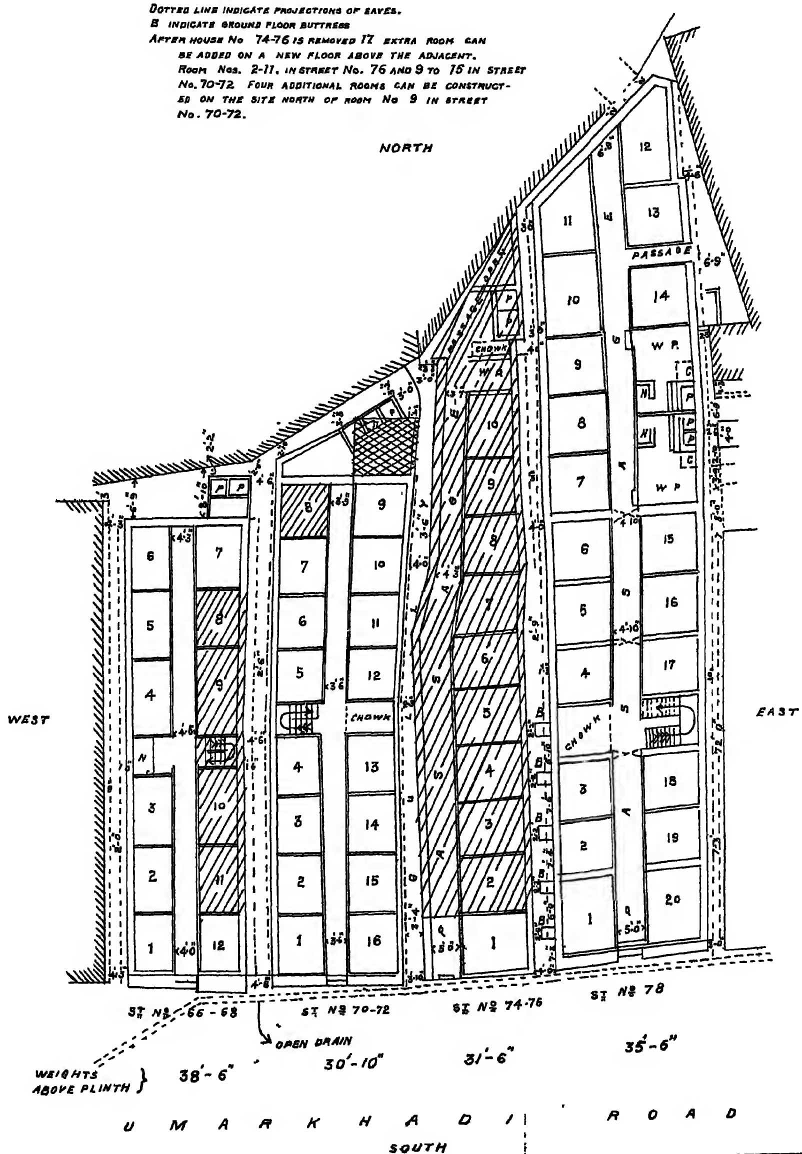
UMARKHADI SCHEME.

PLAN OF FLOORS.

SCALE 20 FEET TO AN INCH.

NOTE:–

HATCHED AREAS INDICATE PROPERTIES WHICH MUST BE ACQUIRED AND CLEARED OF BUILDINGS
CROSSED HATCHED AREA INDICATES SITE AVAILABLE FOR EXTENSION OF EXISTING BUILDING
DOTTED LINE INDICATE PROJECTIONS OF EAVES.
B INDICATE GROUND FLOOR BUTTRESS
AFTER HOUSE No 74-76 IS REMOVED 17 EXTRA ROOM CAN BE ADDED ON A NEW FLOOR ABOVE THE ADJACENT. ROOM Nos. 2-11. IN STREET No. 76 AND 9 TO 15 IN STREET No. 70-72. FOUR ADDITIONAL ROOMS CAN BE CONSTRUCTED ON THE SITE NORTH OF ROOM No 9 IN STREET No. 70-72.



Bombay Improvement Trust

PORTION OF SECOND NAGPADA IMPROVEMENT SCHEME.

PLAN B REFERRED TO IN APPENDIX A § 16

SCALE 40' FEET TO AN INCH

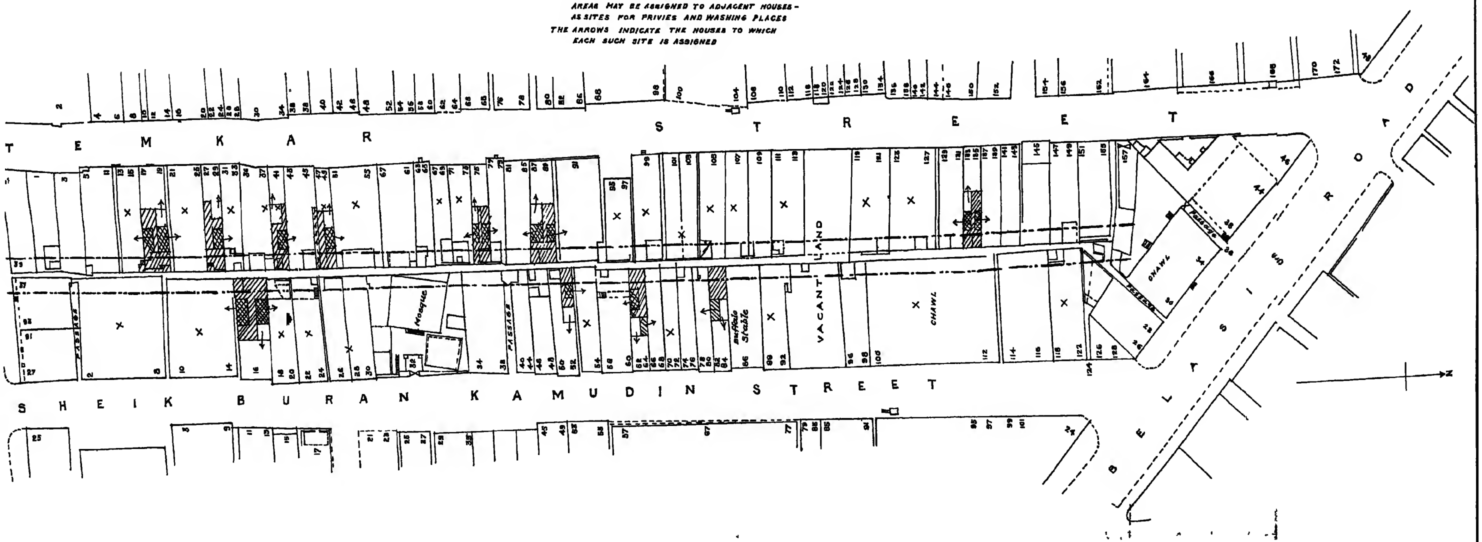
NOTE –

CROSSES DENOTE SUBSTANTIAL HOUSES

CHAIN LINES INDICATE THE STRIP 20' BROAD TO BE CLEARED OF BUILDINGS

HATCHED AREAS ARE THOSE TO BE ACQUIRED AND CLEARED IN ORDER THAT THE CROSS HATCHED AREAS MAY BE ASSIGNED TO ADJACENT HOUSES AS SITES FOR PRIVIES AND WASHING PLACES

THE ARROWS INDICATE THE HOUSES TO WHICH EACH SUCH SITE IS ASSIGNED



Bombay Improvement Trust

PORTION OF SECOND NAGPADA IMPROVEMENT SCHEME.

PLAN B REFERRED TO IN APPENDIX A § 16

SCALE 40' FEET TO AN INCH

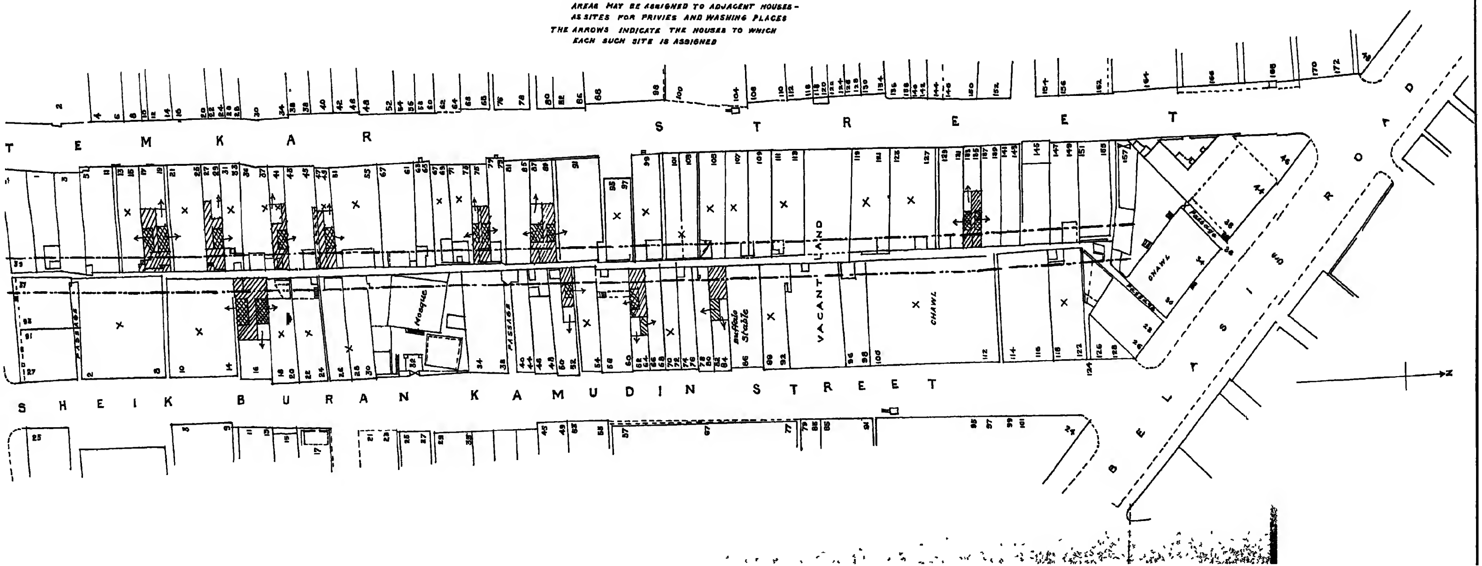
NOTE –

CROSSES DENOTE SUBSTANTIAL HOUSES

CHAIN LINES INDICATE THE STRIP 20' BROAD TO BE CLEARED OF BUILDINGS

HATCHED AREAS ARE THOSE TO BE ACQUIRED AND CLEARED IN ORDER THAT THE CROSS HATCHED AREAS MAY BE ASSIGNED TO ADJACENT HOUSES AS SITES FOR PRIVIES AND WASHING PLACES

THE ARROWS INDICATE THE HOUSES TO WHICH EACH SUCH SITE IS ASSIGNED



Particulars of a block of 8 houses in Nagpada between Temkar Street and Shekh Baran Commodin Street (Plan C).

Street No.	No. of floors	Height of house at edge of proposed 20' rear open space.	No. of Rooms under existing arrangements.			No. of rooms under proposed arrangements (All Sanitary).	Remarks.
			Sanitary.	Insanitary.	Total.		
	No	Ft. in.	No.	No.	No.	No.	It is proposed to transfer privies and washing places from the rear to the centre of each house, to abolish interior rooms and to have on each floor only rooms lighted either from the street in front or from the 20' open space in rear and in some cases extra rooms lighted from the central chouk on the top floor.
62-64	5	32'-3"	5	5	10	9	
66-76	4	47'-6"	16	7	23	17	
78-80	4	25'-9"	7	0	7	8	
82-84	4	19'-6"	6	2	8	8	
93-97	4	39'-0"	9	7	16	8	
99	4	44'-9"	9	11	20	8	
101-103	5	49'-3"	14	10	24	10	
105	4	35'-9"	10	6	16	8	
		Total...	76	48	124	76	

2ND NAGPADA SCHEME

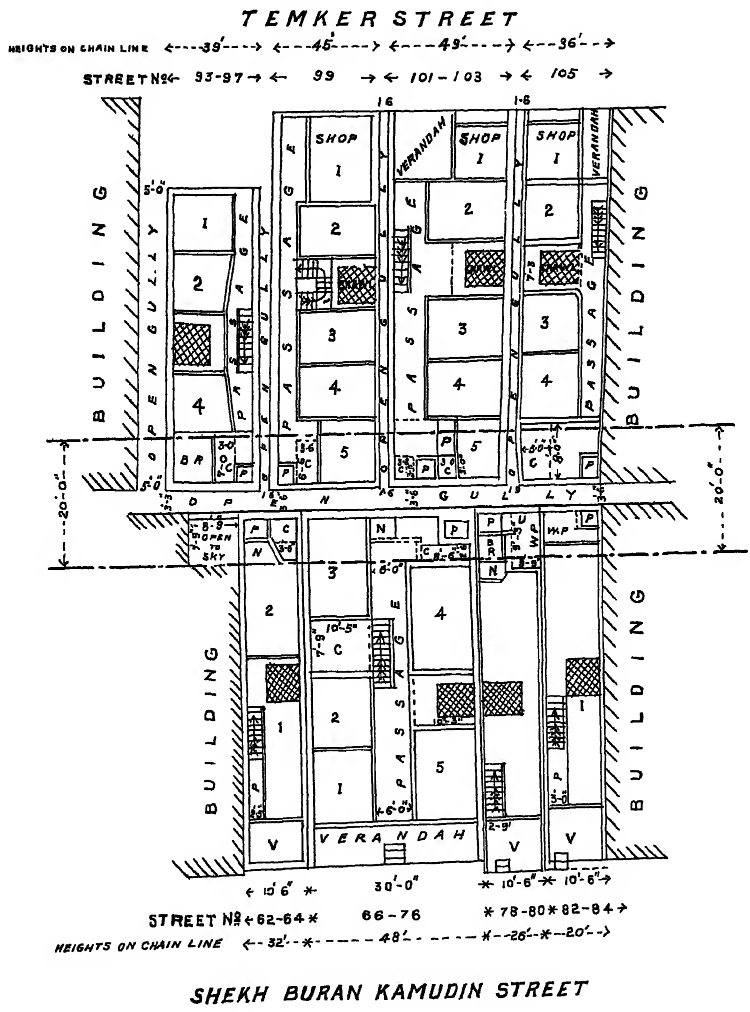
SCALE, 20'-1."

PLAN C. REFERRED TO IN APPENDIX A § 16

Ground Floor Plan.

Note:–

Cross hatched areas denote sites proposed for W. C's and Washing Places after buildings are removed from the 20' space between the Chain Lines.



APPENDIX B.

THE $63\frac{1}{2}°$ RULE AS APPLIED IN CALCUTTA.

Letter to the President, Municipal Corporation, Calcutta, from the Secretary, Bombay Improvement Trust, No. 956 , dated the 6th December 1911:—

"I am directed to request the favour of being informed whether in connection with the Municipal building bye-laws the $63\frac{1}{2}°$ light and ventilation rule applies in Calcutta to buildings reconstructed on old plinths and whether the rule is applied or not. In Bombay the tendency is to treat interference with a man's right to rebuild on his old plinth as confiscatory.

2. In the case of plots belonging to this Trust the $63\frac{1}{2}°$ rule is comparatively easily applied as the Trust can fix open margins in two neighbouring plots and let both plots benefit by margins in both ; but in private plots open space in a neighbour's compound cannot be reckoned on. Will you kindly say if your Corporation have any special way of dealing with this difficulty in Calcutta ? It would be wasteful of space to make every man keep sufficient to comply with the $63\frac{1}{2}°$ rule *in his own land.*

3. The favour of an early reply is requested."

Letter to the Secretary, Bombay Improvement Trust, from the Deputy Chairman, Corporation of Calcutta, No. D. C. 397, dated the 14th December 1911:—

"With reference to your letter No. 9562, dated the 6th December 1911, to the address of the Chairman of the Calcutta Corporation, I have the honour to state that I am not acquainted with the Bombay Municipal Building Bye-laws, but I infer that what you describe as "$63\frac{1}{2}°$ light and ventilation rule," is the rule regulating the open spaces to be left in the rear of the building. I enclose a copy of the Calcutta Building Bye-laws, and I would draw your* attention to Rule 22 of Schedule XVII, which provides for an open space of not less than 10 feet in depth being left at the rear of every domestic building, such space to increase in depth according to the height of the building abutting on it. In Calcutta the building rules apply to new buildings erected on old plinth equally with the buildings constructed on a site previously open, except for the relaxation of Rule 2 provided for in Rule 50 of Schedule XVII. Moreover, under Section 391 of the Calcutta Municipal Act (1899) it is held that any additions or alterations made to a building which do not come within the definition of necessary repairs, are regulated by *all* the Building Rules. The fact that open space may be left in the rear of one domestic building which abuts on the rear of another domestic building, does not exempt the latter building from the operation of Rule 22, nor is any concession made in such a case if the owners of two such buildings wished to leave a common open space less than double the width prescribed for any single building under Rule 22. I may state that there has been no difficulty in applying this rule in Calcutta. It is recognised that in the case of insanitary and ill-ventilated buildings the opportunity for having a sanitary building constructed in conformity with the Building rules, must be utilised when the old building is demolished. In certain cases the General Committee have

*This letter deserves special attention of the Bombay Municipality. If the Bombay bye-laws were brought into line with those of Calcutta on the points here dealt with they would be purged of some of their main defects. J. P. O.

allowed some relaxation of the building Rules under Section 391 of the Act III (B. C.) of 1899 in order to encourage owners to demolish old insanitary buildings and to construct buildings which conform substantially to the Building Rules but it is recognised that such concessions cannot be claimed as a right.

2. I should be glad if you will kindly send me for reference a copy of your own Building Bye-laws."

Extract of Rules from Schedule XVII, Act III of 1899 (*as amended by the Local Government up to* 14*th March* 1911).

2. (1) If a building is situated at the side of a street no portion of the building, except open or balustrated parapets not more than four feet high, shall intersect any of a series of imaginary lines drawn across the street at an angle of forty-five degrees with the plans of the ground, such lines being drawn from the street alignment on the side of the street which is the more remote from the building in question from a height of two feet above the centre of the street. Height.

Provided as follows :—

(i) where the said street is joined at an angle by another street facing the building, the height of the building measured from two feet above the centre of the street and excluding parapets as aforesaid shall not in any case exceed the width of the street in which it is situated, together with the width of any set-back which may be made, *plus* half the width of the street facing it.

(ii) Nothing herein contained shall affect the erection of a building abutting upon, or situated at the site of a street of not less than 60 feet in width, if such building does not exceed 80 feet in height ; and

(iii) no building exceeding 80 feet in height shall be erected without the special permission of the General Committee.

Explanation.—If a building be placed at the edge of the street, its height measured from two feet above the centre of the street and excluding parapets as aforesaid must not exceed the average width of the street facing the site ; but, if the building or one or more of its storeys be set-back, the height of the building may be increased subject to the condition that no portion of the building, after the height is increased, intersects any of the aforesaid lines.

2. (2) In the case of any building which is re-erected in a street in existence at the commencement of this Act, the angle at which the lines referred to in sub-rule (1) are to be drawn shall be forty-six and-a-half degrees instead of forty-five degrees.

Provided as follows :—

(i) the height allowed under this rule shall in no case be more than thirty-six feet ; and

(ii) nothing contained in this sub-rule shall authorise the re-erection of any building so as to make it higher than any building which at the commencement of this Act was standing in the same place.

2. (3) Notwithstanding anything contained in sub-rule (1) or sub-rule (2), the Corporation may, by order published in the *Calcutta Gazette*, declare that, in any street specified in the order, the erection of two-storeyed buildings not exceeding twenty-eight feet in height, excluding two feet for the plinth and excluding open or balustraded parapets not more than four feet high, will be permitted without complying with the requirements of those sub-rules.

(4) If a building is situated on a corner plot, so as to abut upon more than one street, the height of the building shall be regulated by the wider of such streets so far as it will abut or abuts upon such wider street, and also so far as it will abut or abuts upon the narrower of such streets to a distance of fifty-five feet from the wider street :

Provided that, if the narrower street does not exceed eight feet in width, the height of the building shall be regulated by the wider street so far as it will abut or abuts upon the narrower street.

(5) Notwithstanding anything contained in sub-rule (1), (2) or (4)—

(*a*) a building of not more than one storey and not exceeding fourteen feet in height above the centre of the street; and

(*b*) if the owner, by a free gift of a portion of his land to the Corporation, makes the street not less than twelve feet wide in front of his site, then a two-storeyed building not more than twenty-eight feet high,

may be erected without complying with the requirements of those sub-rules.

Open space in rear of building regulating the rear height.

22. (1) Except in localities where the erection of only detached buildings is allowed, there must be in the rear of every domestic building an open space extending along the entire width of the building and belonging exclusively to the building, unless the back of the building abuts on an open square or the like of not less than twenty feet in width, which is dedicated to public use and is consequently not likely to be built upon :

Provided that, if the back of such building abuts on a public street which is less than twenty feet in width, an owner, on giving up to the Corporation a sufficient portion of his land to make such public street not less than 20 feet wide, may be allowed to build on the very edge of his remaining land without being required to leave any such open space.

(2) The minimum distance across such space from every part of the building to the boundary line of the land or building immediately opposite such parts shall be 10 feet:

Provided that in the case of any building in which there are both an outer and an inner courtyard, a minimum distance of six feet shall be permitted.

(3) No portion of the building excluding open or balustraded parapets not more than four feet high shall intersect any of a series of imaginary lines drawn across such space at an angle of sixty-three and-a-half degrees with the plane of the ground, such lines being drawn from the line limiting the width of such space at the side thereof which is the more remote from the building, at the level of the plinth of the building;

51

Provided that, in the case of two-storeyed buildings the angle shall be increased from sixty-three-and-a-half to sixty-eight degrees.

Explanation.—If the building be placed at the edge of such space, its height, measured from the level of the plinth and excluding parapets referred to above, must not exceed twice, or, in the case of a two-storeyed building, two-and-a-half times the width of the space, but if the building or one or more of its storeys be set-back, the height of the building may be increased, subject to the condition that no part of the building, after the height is increased, intersects any of the aforesaid lines.

(4) For the purposes of this rule, the rear of a building shall be deemed to be that face which is farthest from any street at the side of which the building is situated :

Provided that where a building is situated at the side of more than one street, the rear of the building shall, unless the Chairman otherwise directs, be deemed to be that face which is farthest from the widest of such streets.

Relaxation of Rule 22 in case of irregular site.

23. If any person desires to erect a domestic building, in a street laid out before the commencement of this Act, upon a site which is of such a nature that it is impracticable to provide an open space in the rear of the building of the dimensions prescribed by Rule 22, the General Committee may relax the provisions of that rule :

The principle of this Rule 23 might well be adopted in Bombay. I draw special attention to proviso (*b*).
J. P. O.

Provided that—

(*a*) such open space shall be left as the General Committee may consider practicable, having regard to all the circumstances of the case ; and

(*b*) not more than two-thirds of the total area of the site shall be occupied by masonry buildings or verandahs.

Relaxation of Rule 2.

50. In applying Rule 2 in the case of an alteration of, or addition to, any building which was erected before the commencement of this Act, the angle at which the lines referred to in sub-rule (1) of that rule are to be drawn shall be forty-six-and-a-half degrees instead of forty-five degrees :

Provided that nothing contained in this rule shall authorize any addition to a building which would make it higher than any building, which, at the commencement of this Act, is standing in the same place.

Construction of Rules 30 to 36 or 47 to 49.

52. (1) Rules 32 to 36 or Rules 47 to 49, as the case may be, shall not be applied in the case of any alteration of, or addition to, a building unless one or more of the following works is, or are, undertaken, namely :—

(*a*) the construction of a roof or an external or party wall ;

(*b*) any repairs to the building which involve the reconstruction of a masonry wall and lift shaft or a chimney after the same has been entirely or in great part demolished ;

(*c*) the closing of any door or window in an external wall ;

(*d*) the construction of an internal wall or partition ;

(*e*) any other alteration of the internal arrangements of a building which affect an alteration of its courtyard or courtyards or its drainage, ventilation, or sanitary arrangements, or which affect its security ;

(*f*) the addition of any building, room, outhouse, or other structure;

(*g*) the roofing of any space between one or more walls and buildings;

(*h*) the conversion into more than one place for human habitation of a building originally constructed as one such place;

(*j*) the conversion of two or more places of human habitation into a greater number of such places;

(*k*) the alteration of a building for the purpose of effecting a partition amongst joint-owners.

52. (2) In the case referred to in clause (*g*) of sub-rule (1) the said Rules 30 to 36, or Rules 47 to 49, as the case may be, shall apply only as regards the structure which is formed by roofing a space, and not as regards adjoining buildings.

EXTRACT FROM THE CALCUTTA MUNICIPAL ACT.

Application of Act to alterations of, and additions to, buildings.

391. (1) Without the consent of the General Committee, no person shall make any alteration of, or addition to, any building in such manner that, when so altered or added to, the building will, by reason of such alteration or addition, not be in conformity with the provisions of this Chapter or Schedule XVII or any orders, rules, or bye-laws made under this Act, relating to the erection of buildings. Application of Act to alterations of, and additions to, buildings.

(2) Every alteration of, or addition to, a building, and any other work made or done for any purpose in, to, or upon a building shall, so far as regards such alteration, addition, or other work, be subject to the provisions of this Chapter and Schedule XVII, and any orders, rules, or bye-laws made under this Act, relating to the erection of buildings:

Provided as follows:—

(*a*) none of the said provisions, orders, rules, or bye-laws shall apply in the case of a necessary repair not affecting the position or dimensions of a building;

(*b*) sections 370 to 383 (*re*: masonry buildings) or sections 384 to 390 (*re*: huts), as the case may be, shall not apply in the case of any alteration of, or addition to, a building unless one or more of the works referred to in Rule 52 of Schedule XVII is or are under taken; Corresponding to sections 337 to 353 of the Bombay Municipal Act. J. P. O.

(*c*) provisional permission to proceed with any of the works referred to in the said Rule 52 may be granted in the cases, and subject to the conditions prescribed in this behalf in the said Schedule XVII.

(3) If any question arises as to whether any alteration, addition, or other work is a necessary repair not affecting the position or dimensions of a building, the matter shall be referred to the General Committee, whose decision shall be final.

NOTE BY DEPUTY ENGINEER ON THE LIGHT AND VENTILATION RULES OF CALCUTTA AND BOMBAY.

1. The Light and Ventilation Rules of the Calcutta Municipality are in some cases much more stringent than those of the Bombay Improvement Trust, in other cases they are not quite so strong taken as a whole ; however they are, I should think, more stringent if the law is carried out as laid down. This is a point which should never be forgotten in connection with Building Bye-laws, as one may have the most uptodate and most satisfactory Bye-laws that were ever written, and yet owing to slackness in applying them may get the worst results on record.

2. The first rule of the Calcutta Municipal Bye-laws referring to this subject is No. 17 of part IV on page 12, which runs as follows :—

Proportion of site for dwelling-house which may be built upon.

The total area covered by all the buildings (including verandahs) on any site used for a dwelling-house shall not exceed two-thirds, or, in localities where the erection of only detached buildings is allowed, one-third of the total area of the site ; and the area not so covered shall belong exclusively to the dwelling-house and shall be retained as part and parcel thereof.

3. The first portion of this rule is the same as the old one-third open space rule of the Bombay City Improvement Trust, which for various and excellent reasons the Trust has abandoned. The rule however does not stop there, but goes further in that in localities where the erection of only detached buildings is allowed there must be two-thirds of every plot kept as open space ; this would be a very desirable rule no doubt in portions of Schemes like Schemes V (Dadar-Matunga) and VI (Matunga-Sion), but would be rather hopeless to apply in a City, at any rate, such a City as Bombay, which is precluded from expanding on two sides. The reason why the Trust have abandoned the one-third open space rule is that satisfactory results can be got in this City by the use of the $63\frac{1}{2}°$ rule, while permitting a larger area to be built upon.

This rule is as follows :—

$63\frac{1}{2}°$ Rule applied to Side open spaces.

An air space at the side of the building obtained as follows :—An imaginary horizontal plane shall be assumed at the level of the floor of the lowest habitable room of which any portion of the required window area opens on to such air space. An imaginary diagonal plane shall be assumed making an angle of sixty-three-and-a-half degrees with the imaginary horizontal plane and whose intersection with the said horizontal plane shall be a line parallel to the nearest boundary of the adjoining plot and vertically over the said boundary. No portion of the building above the said horizontal plane and depending for light and ventilation on this side air space shall be at a less horizontal distance than 10′ from the said boundary, nor project beyond the said imaginary diagonal plane, except chimneys, dormers,

gables, turrets, or other architectural ornaments aggregating in all no more than one-third of the side elevation of such building.

63½° Rule applied to Interior open spaces.

Every Ventilation chowk within a building shall consist of an interior open space having an area not less than one-fourth of such portion of the aggregate floor area of all the rooms abutting thereon as may depend on the same for the minimum required opening for light and ventilation, and of a width in every direction not less than half the height measured from the floor of the lowest habitable room opening into it to the eaves or top of the parapet of the opposite wall, subject to a minimum width of 10 feet.

Such interior open space shall be and be kept free from any erection thereon, and shall be and be kept open to the sky for its entire area and no portion of any verandah, gallery or other projection of a building abutting on any such interior open space shall project over such interior open space other than the main roof eaves and those only to the extent of 18″. And every interior open space shall have as a means of access thereto a passage on the ground floor communicating with either a street or a space open to the air. Such passage shall be not less than 6 feet wide and 8 feet high and shall not be closed or obstructed at either end or at any part thereof otherwise than by a door or gate having at least three-fourths of its area open to perflation of air. All such interior open spaces shall be rectangular.

63½° Rule applied to the Rear open spaces.

The height of any such building in relation to the open space required in the rear thereof shall be fixed and ascertained as follows :—

(*a*) An imaginary horizontal plane shall be assumed at the level of the surface of the Crown of the adjoining street such level to be fixed by the Engineer where the surface of the said crown is not on one level.

(*b*) One or more imaginary diagonal planes shall be assumed, inclined at an angle of 63½° to the horizontal plane, such that the lines of intersection shall be parallel to the frontage line and shall cut the rear boundary of the plot at such point as the Engineer may fix.

(*c*) When the land at the rear of any such building and exclusively belonging thereto abuts immediately upon a street or upon an open space which is dedicated to the public, or the maintenance of which as open space is secured permanently or to the satisfaction of the Board by covenant or otherwise, the diagonal plane or planes shall be assumed such that the intersection with the horizontal plane shall be parallel to the frontage line of the plot and shall cut the further boundary of such street or open space at such point as the Engineer may fix subject to a maximum distance of 20 feet from the rear boundary of the plot and it shall not be necessary to provide any open space in the rear of such building.

(*d*) No part of such building shall extend above such diagonal plane or planes except chimneys, dormers, gables, turrets, or other architectural ornaments aggregating in all not more than one-third of the width of the rear elevation of such building, and except any building which under the provisions of these regulations is permitted on the open space.

4. In Mandvi-Koliwada (Scheme No. VIII) the proportion covered by buildings is as much as 86 per cent. of the total area of the plots leased giving 14 per cent. of open space only, but at the same time complying with the 63½° Rule. From both the sanitary and economical points of view the result is highly satisfactory.

5. In the outlying Schemes it is quite as easy to lay down building lines which can regulate the amount of building on any plot or sets of plots. Of course, when comparing the Improvement Trust with a Municipal Corporation, one must remember that the two bodies are dealing with very different things. In the case of the Trust we are dealing with Trust Estates on which we have a perfect legal right to say that they shall not be built upon except in certain ways and can enforce our rights in this connection even if we were to insist on things which were unreasonable. The Municipality, on the other hand, has to deal with buildings erected on private properties and can only lay down general rules.

6. The Calcutta Rule relating to the Size and Ventilation of inhabited rooms is as follows :—

Size and Ventilation of inhabited rooms.

20. Every room in a domestic building which is intended to be used as an inhabited room—

(*a*) *must be in every part not less than 10 feet in height, measured from* the floor to the underside of the beam on which the roof rests ;

(*b*) must have a clear superficial area of not less than eighty square feet ; and

(*c*) must be provided for purposes of ventilation, with doors or windows opening directly into the external air, or into a verandah and having an aggregate opening of not less than one-fourth of the superficial area of that side or one of those sides of the room which faces or face an open space.

7. This rule is identical with that of the Bombay Municipality, except that in Calcutta the room is required to be not less than 80 square feet in area, whereas in Bombay it is required to be not less than 100 square feet; the portion of the rule relating to doors and windows is an insanitary one for the reasons given in my note of 9th May 1910 (copy attached).

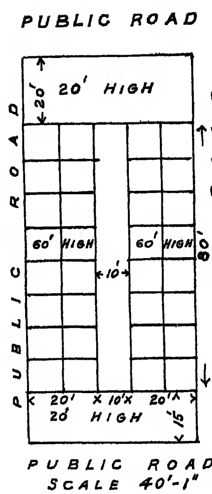
8. Calcutta has an additional and very excellent rule regarding the ventilation of the staircase which requires that in the case of flats (also, presumably, of chawls) the principal common staircase must be adequately ventilated upon every storey.

9. Calcutta Rules as regards internal open spaces are a mixture of those of the Bombay Municipality and the Bombay Improvement Trust. They are not so stringent as the Improvement Trust and are much more stringent than Bombay Municipality ; for instance, by Calcutta Rules the minimum superficial area of any internal open space must be not less than $\frac{1}{4}$th of the aggregate floor area of all the rooms and verandahs abutting on it. The Bombay Rule is $\frac{1}{10}$th of the floor area. The Improvement Trust rule is that it must be wide enough and long enough to permit of every room depending on it for light or air, getting an angle of $63\frac{1}{2}^\circ$ of light. Again under the Calcutta rule the minimum width of an internal open space is 8 feet. The Bombay Municipality make the minimum width 6 feet, under the Improvement Trust the minimum width is 10 feet.

10. In addition to these rules the Calcutta Municipality enforce the $63\frac{1}{2}°$ rule as practised by the Improvement Trust with the following modifications:—

(1) The angle is taken at Plinth level instead of ground level as with the Trust.

(2) In the case of dwelling-houses which have more than two storeys, the storeys above the second shall not be taken into account in applying the $63\frac{1}{2}°$ rule to internal spaces if they are not built on more than two sides of the house.



11. There is nothing very much to urge against the 1st of these modifications, but the second is rather retrograde, and I imagine has not been given very full consideration, as it is quite conceivable that modification might lead to the most undesirable state of affairs as will be seen from the marginal sketch which shows the building with a central 'chowk' on which two sets of rooms on each floor depend for light and air, the two long sides being 5 storeys high and the two short sides being of 2 storeys. The result would be that the internal line of rooms on the ground, 1st and 2nd floors of the longer sides would be very badly lighted indeed; in fact, the ground floor would be pitch-dark. It seems to me that in drawing the Calcutta Rules they have forgotten this possibility, and have only considered the case of two sides at right angles to each, other which would not be objectionable to any great extent although even in that case the ground floor rooms on the side, which was not built up, would have to depend on reflected light.

12. As regards the $63\frac{1}{2}°$ rule applied to the open spaces in the rear of the building and regulating the height of the building in the rear, the Bombay Municipality has no such rule. The Calcutta Corporation rule is very well and clearly worded as follows:—

Open space in rear of building regulating the rear height.

22. (1) Except in localities where the erection of only detached buildings is allowed, there must be in the rear of every domestic building an open space extending along the entire width of the building and belonging exclusively to the building, unless the back of the building abuts on an open square or the like of not less than twenty feet in width, which is dedicated to public use and is consequently not likely to be built upon.

Provided that if the back of such building abuts on a public street which is less than twenty feet in width, an owner on giving up to the Corporation a sufficient portion of his land to make such public street not less than twenty feet wide, may be allowed to build on the very edge of his remaining land, without being required to leave any such open space.

(2) The minimum distance across such space from every part of the building to the boundary line of the land or building immediately opposite such parts shall be 10 feet.

Provided that, in the case of any building in which there are both an outer and an inner courtyard, a minimum distance of 6 feet may be permitted.

(3) No portion of the building, excluding open or balustraded parapets not more than four feet high, shall intersect any of a series of imaginary lines drawn across such space at an angle of sixty-three and-a-half degrees with the plane of the ground, such lines being drawn from the line limiting the width of such space at the side thereof which is the more remote from the building, at the level of the plinth of the building.

Provided that, in the case of two-storeyed buildings, the angle may be increased from sixty-three and-a-half to sixty-eight degrees.

Explanation.

If the building be placed at the edge of such space, its height, measured from the level of the plinth and excluding the parapets referred to above, must not exceed twice, or, in the case of a two-storeyed building, two-and-a-half times, the width of the space; but, if the building or one or more of its storeys be set back, the height of the building may be increased, subject to the condition that no part of the building, after the height is increased, intersects any of the aforesaid lines.

(4) For the purposes of this rule the rear of a building shall be deemed to be that face which is furthest from any street at the side of which the building is situated.

Provided that, where a building is situated at the side of more than one street, the rear of the building shall, unless the Chairman otherwise directs, be deemed to be that face which is furthest from the widest of such streets.

13. This rule is the same in effect as the Improvement Trust Rule but has this additional provision which is a most useful one namely "provided that if the back of a proposed building abuts on a public street which is less than 20 feet in width an owner on giving up to the Corporation a sufficient portion of his land to make such public street not less than 20 feet may build upto the edge of his land without leaving a rear open space on his land, the $63\frac{1}{2}^{\circ}$ rule of course applying." The Calcutta Corporation modify this rule to a certain extent, and for reasons which do not appear, in the case of two-storeyed buildings in this case the angle is increased from $63\frac{1}{2}^{\circ}$ to 68°, *i.e.*, from the angle whose tangent is 2 to 1 to that whose tangent is $2\frac{1}{2}$ to 1.

14. As regards the open space at the sides of the buildings the Calcutta Municipality do not appear to apply the $63\frac{1}{2}^{\circ}$ rule and this appears to me to be a serious omission especially in Calcutta where they do not allow a dwelling-house to be attached to the adjacent building but insist on having space between them; the rule being that building must be at least 4 feet away from the boundary of the plot if a public open space is on the other side of the boundary line; if such open space is not on the other side then the distance of a building from the boundary must be at least 6 feet. Many examples of the undesirability of not applying the $63\frac{1}{2}^{\circ}$ rule on the sides of buildings are to be observed in Bombay and I for one distinctly prefer that the building should be attached to the adjacent building or that the $63\frac{1}{2}^{\circ}$ rule should be insisted upon. These two alternatives are those permitted by the Trust.

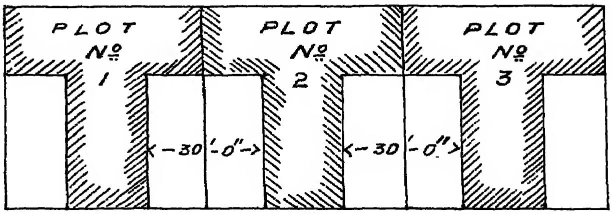
F. WATSON,

A. M. INST. C. E.,

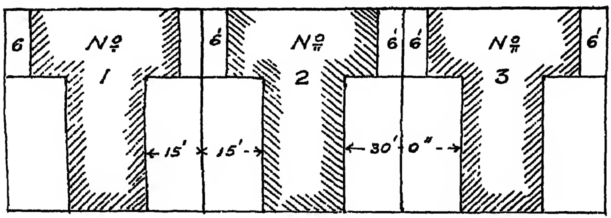
Deputy Trust Engineer.

1. I concur with Mr. Watson in his remarks on the $63\frac{1}{2}^\circ$ rule.

2. The ideal development for continuous blocks of buildings is undoubtedly the T arrangement.



GROUND FLOOR PLAN OF "T" SHAPED BUILDINGS, HEIGHT OF BUILDING 60' OPEN SPACES 30' WIDE.



UPPER FLOOR PLAN OF "T" SHAPED BUILDINGS SHOWING 12' OPENING IN FRONT FOR PERFLATION OF AIR.

To meet the charge that a continuous frontage is prejudicial to satisfactory perflation of air in the interior of the block an open space 6′ wide between the building and the plot boundary might be left on both sides extending from the front of the building to the rear open space the size of which is governed by the $63\frac{1}{2}^\circ$ rule. The 6′ open space to commence at the 1st floor level ; the ground floor frontage being continuous. All rooms abutting on the 6′ open space (12′ with the neighbours' 6′ open space) must of course receive light from other sources according to the $63\frac{1}{2}^\circ$ rule.

R. J KENT,
A. M. INST. C. E.,
Trust Engineer.

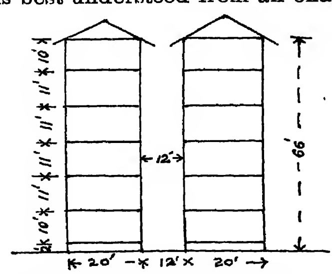
DEPUTY ENGINEER'S NOTE NO. 3645 OF 9-5-1910 REFERRED TO IN PARA. 6 OF HIS NOTE NO. 6016 OF 13-11-1910.

Comparison of Bombay Municipal Bye-laws re Ventilation of buildings with those of Improvement Trust.

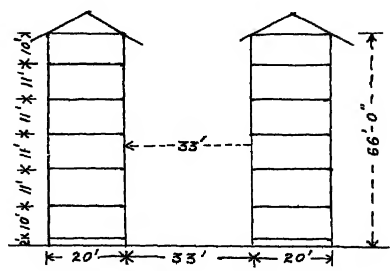
1. In the Municipal Bye-laws there are very few rules for ventilation of buildings, and those which exist do not appear to me to be such as can be taken as a standard for Trust Estates. The differences between the Trust rules on this subject and the Municipal rules are chiefly due to the fact that the Municipality is trying to make the best of a bad state of things which already exists and which they cannot change all at once. In the case of the Trust we are dealing with things *de novo* and therefore can insist on sanitary conditions being maintained.

2. Taking the Municipal Bye-laws on this subject *seriatim* :—

Bye-law No. 41 (1).—The Municipal rule is that every room intended for human habitation shall have the whole of at least one side abutting on an exterior or interior open space. The Trust require practically the same thing. The difference in the two rules comes in the definition of what constitutes the exterior open space, and the interior open space. According to the Municipal Building Bye-laws the minimum open space is given by a scale. See attached *Exhibit A.* In the case of the Trust the minimum external open space is not defined as regards its width or other dimensions but is fixed as being such width as will permit of every room opening on to it, receiving a minimum of 63½° of light. In the same way the Municipal Bye-laws define the minimum interior open space as being a space of not less than 6 feet wide, the area of which is not less than 1/10th of the aggregate floor area of all rooms abutting on it. The Trust define the minimum interior open space in exactly the same way as the minimum exterior open space is defined namely that every room depending wholly on the interior open space for its light and air shall receive not less than 63½° of light. The working of the two different rules is best understood from an example.

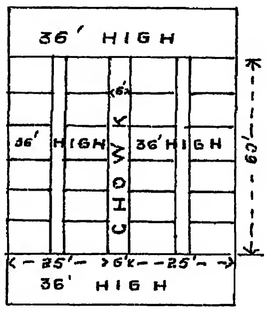


ACCORDING TO BOMBAY MUNICIPAL RULE
SCALE 40'-1".



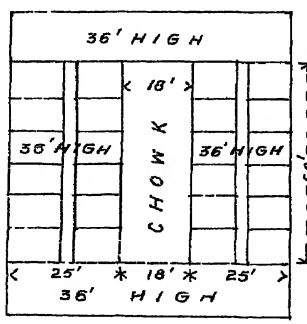
ACCORDING TO BOMBAY IMPROVEMENT TRUST RULE
SCALE 40'-1"

3. Take for instance two buildings both 66 feet high side by side both having rooms on the ground floor depending for light and air on the open space between the two buildings. In the case of the Municipal rule these buildings need only be 12 feet apart, in the case of the Trust they must be 33 feet apart. In the case of the Municipality the rooms on the ground floor will be in a state of continual twilight whereas in the case of the Trust the occupants of the rooms. would be able to see the sky without going out of their room. With 12′ space both Trust and Municipality would allow houses 24′ high but while Trust would not allow the height to be increased, Municipality would allow increase upto 66″, and every increase would lower the standard of light and ventilation in the lower rooms.



ACCORDING TO MUNICIPAL RULE

SCALE 40′–1″



ACCORDING TO BOMBAY IMPROVEMENT TRUST RULE

SCALE 40′–1″.

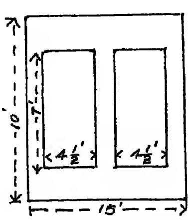
4. To illustrate the difference of the rules in the case of interior open space, suppose that we have a 3 floor building 36′ high, and that in this building there are on each floor 12 rooms, each 100 square feet in area, and that the 12 rooms abut on either side of a central chowk and are dependent for their light on that chowk and that the side of each

of the rooms next the chowk is 10 feet wide. Under the Municipal rules the size of that chowk may be .6 feet wide and 60 feet long. In the case of .the Trust the chowk must be 18 feet wide and 60 feet long. The sanitary result of the Municipal rule can be better imagined than described. Rooms on the ground floor would enjoy rather less light than a mediæval dungeon, and as to their ventilation the less said the better.

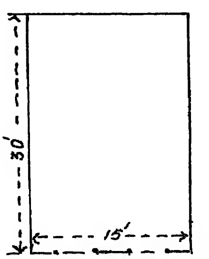
In the lowest and worst lighted rooms on Trust Estates, you can see the sky by lying on the floor with your head within 4 feet of a wall in which is a window whose top is 8 feet above ground level ; whereas outside Trust Estates your eye would have to be within 1⅓ feet of the wall.

5. *Bye-law* 42 of the Municipal Bye-laws provides the same requirements as regards the size and superficial area of rooms as the Trust rules. It provides that every room shall be ventilated by means of doors or windows which open directly into the external air and have an aggregate opening equal to not less than one-fourth of the superficial area of that side of the room which faces an open space. Thus in a Kamatipura house with 7 feet frontage a room 10 feet high, 7 feet broad and 30 feet deep would pass Municipal Bye-law if it had a door 6′×3′ and no window. The Trust rule on the other hand is that such openings shall not be less than one-seventh of the superficial floor area of the room and of such opening, the window or grating area shall not be less than one-fifteenth of the floor area.

6. The difference between these two rules is best seen from an example:—Supposing we have a room 15 feet wide by 30 feet deep by 10 feet high with the 15 feet side abutting on the open space, under the Municipal rules a window 6′-3″ high by 6 feet wide would suffice. In the Trust rules two windows 7 feet high by 4½ feet wide would be required. In the case of the room complying only with Municipal rules there would be very little light for the last 10 feet of its depth. In fact if the external air space were the minimum allowed by the other rules before mentioned there would be no light at all.

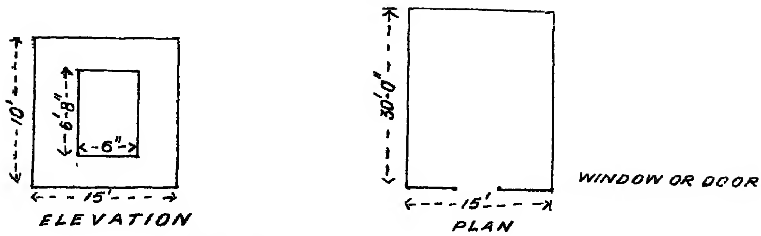


ELEVATION



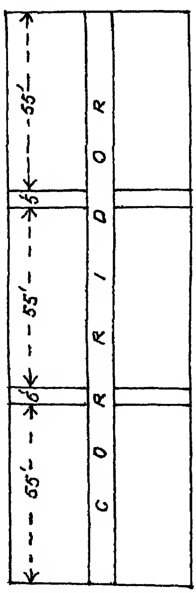
WINDOW DOOR OR WINDOW 7′ HIGH × 4½′ WIDE
PLAN

ACCORDING TO TRUST RULE



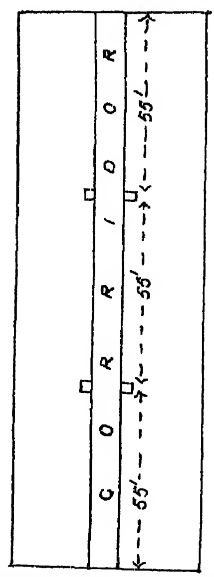
ACCORDING TO MUNICIPAL RULE

7. *Bye-law* 43 provides for certain gratings in back to back rooms; these are not mentioned in the Trust's Bye-laws as in the cases of chawls, back to back rooms are prohibited and in the case of other buildings there is no difficulty with regard to through ventilation.



AS INTENDED

SCALE 40'-1"



AS ACTUALLY REQUIRED
BY BYE-LAWS

SCALE 40'-1"

8. *Bye-law* 44 provides that the corridors in chawls shall be open to the air at both ends and shall if they exceed 55 feet in length have a through passage from side to side open to the air at distances of at most 55 feet. The first part of the rule is the same as provided by the Trust. The second part has not been provided as our other rules are sufficient to preserve Sanitary conditions, but in the case of our own chawls we provide the open chowk for ventilation at about this interval.

This is the rule as intended by the Municipal Executive; but actually the rule in the Bye-laws requires only two small shafts or chimneys $2' \times 2\frac{1}{2}'$ on each side of corridor every 55 feet of its length.

(Sd.) F. WATSON,
A. M. INST. C.E.,
Dy. Trust Engineer.

EXHIBIT A.

(Referred to in para. 2 of Deputy Engineer's Note 3645 of 9-5-10.)

In the case of dwellings other than chawls :—

Minimum width of open space throughout.	Where height of building above the plinth does not exceed
2 feet.	22 feet.
3 ,,	33 ,,
4 ,,	44 ,,
5 ,,	55 ,,
6 ,,	66 ,,
7 ,, where height exceeds	66 ,,

In the case of chawls :—

5 feet.	22 feet.
6 ,,	33 ,,
7 ,,	44 ,,
8 ,,	55 ,,
9 ,,	66 ,,
10 ,, where height exceeds	66 ,,

APPENDIX C.

(Referred to in paras. 15, 17 and 18 of Note.)

METHOD OF DEALING WITH OBSTRUCTIVE HOUSES, DISPOSING OF THEIR CLEARED SITES AND ASSESSING BETTERMENT RATES LEVIABLE ON ADJACENT PROPERTIES.

1. It is difficult to lay down the general rules which should govern the disposal of sites of obstructive houses because of the great variety and complexity of the cases that are met with.

2. The Trust will do well to select only cases in which *all* the neighbouring houses are substantially benefited by the clearance. It is very desirable that there should be some easily applicable method of assessing the betterment rate, and that, to get the matter settled once for all, the assessor should take into account potential betterment to result on reconstruction of the houses concerned and not merely the immediate actual benefit to the houses as they now stand.

3. In order to reduce house owners' expenses as far as reasonable, it should be recognised that a part of the cost of the operations may be paid from the public purse and the Trust may be empowered to recover not more than two-third and not less than half of that cost in the shape of betterment rate.

4. Various systems of distribution of cost have been tried in many actual cases, and it has been found necessary to discard those methods which aim at distributing the burden in strict proportion to the immediate benefits gained by the several houses because of their complexity. The system most easily applicable and least open to the objection that it results in unequal treatment is that which has been adopted in the 4 cases set out here, *viz.*, to distribute the burden to the several houses in proportion to the length of their several frontages on the acquired area, and give the owners the option of paying a lump sum or an annual betterment rate.

5. In order to leave every house-owner some margin of profit, it is proposed to recover in any year only so much of the betterment rate as added to the general tax payable in the year gives the equivalent of a general tax at a 25 per cent. rate (the present rate is 10⅝ per cent.) and to remit the remainder. Thus in the year of the clearance the assessments will be low in consequence of so many rooms having been till then condemned and there will be pretty big remissions of betterment rate: but the clearance of the site will result in the removal of the prohibition against occupation, of several rooms, and rents and assessments will rise: *pari passu* the amount actually paid out of the increased rents towards the betterment rate will rise and remission will fall till probably in a few years, when better rents are obtained, *e.g.*, when an extra storey rendered permissible by the conversion of the obstructive house into an open space is constructed, there will be no remission and general tax and betterment rates together will fall below 25 per cent.

6. The effect of this limitation in individual cases will be to raise the Trust's share and decrease the private owner's share of the cost of the clearance operations, so that if (*e.g.*) the original distribution assigned 60 per cent. to the owners and 40 per cent. to the Trust, the actual effect may be that they pay half and half. This can be roughly allowed for in fixing the

original distribution so as to suit the pockets of the owners. The poorer the owners are and the more urgently improvement is required, the larger should the Trust's share be.

7. In return for the Trust's share of the cost they (or the Municipality) will have the right to make use of the cleared sites for offices, godowns, and other purposes set out in para. 18 of the main note (q. v.)

8. In the Telwadi case dealt with in Plan and Statement **A**, it is found equitable to recover no more than half the cost of acquisition from the owners of the houses benefited by the removal of the obstructive house. None of these owners will get any remission in 1912-13 as the betterment rate in that year will fall short of the maximum leviable. House No. 33 can be raised by one storey and houses Nos. 34 and 35 by two each as a result of the creation of the open space; so the maximum leviable in these cases will ultimately increase and the owners will have no difficulty in paying the full betterment rate. In all probability the public purse will ultimately pay half the cost of the acquisition.

9. In another Telwadi case, dealt with in Plan and Statement **B**, it is found equitable to recover two-thirds of the cost of acquisition from the owners of houses benefited by the removal of the obstructive house. The owner of house No. 13 will get remission of Rs. 101 in 1912-13 and the total betterment rate recoverable in that year will be Rs. 379 instead of the maximum Rs. 480. The Western portion of house No. 13 can be raised by two storeys and the Southern portion of house No. 22 can be raised up to a maximum height of 70 feet (its present height being only 26 feet) as a result of the creation of the open space, so the maximum leviable in these cases will ultimately increase and the owner of No. 13 will then have no difficulty in paying an increased betterment rate. In all probability the public purse will ultimately pay about 40 per cent. of the cost of acquisition.

10. In the Kolbhatwadi case dealt with in Plan and Statement **C**, it is found equitable to recover 60 per cent. of the cost of acquisition from the owners of houses benefited by the removal of the back of the obstructive house. Two of the owners, *i.e.*, those of houses Nos. 37 and 38 will get a remission in 1912-13 while in the remaining two cases the betterment rates in that year will fall short of the maximum leviable. Houses Nos. 35 and 38 can be raised by two storeys each as a result of the creation of the open space, so the maximum leviable in those cases will ultimately be increased and the owners will have no difficulty in paying full betterment rate. In all probability the public purse will ultimately pay 45 per cent. of the cost of acquisition.

11. In the Umarkhadi case dealt with in Plan and Statement **D**, it is found equitable to recover two-thirds of the cost of acquisition from the owners of the houses benefited by the removal of the obstructive house. None of these owners will get any remission in 1912-13 as the betterment rate in that year will fall short of the maximum leviable. In all probability the public purse will ultimately pay one-third of the cost of acquisition. All the houses abutting upon the site of the obstructive house can be raised by at least two storeys each as a result of the creation of the open space, and the extra rooms thus supplied will more than make good the accommodation lost by the demolition of the obstructive house.

STATEMENT A.

Telwadi.

Particulars of the obstructive house. Street Nos. 31-32. Gross annual assessment Rs. 604. Cost of acquisition estimated for the purposes of the following Statement at 16⅔ Y. P., on Rs. 604 plus 10 per cent. for contingencies = Rs. 11,100. Area = 62 square yards. Rate per square yard = 11,100 ÷ 62 = Rs. 179. 50 per cent. of cost to be recovered from owners = Rs. 5,550 (*vide* column 4).

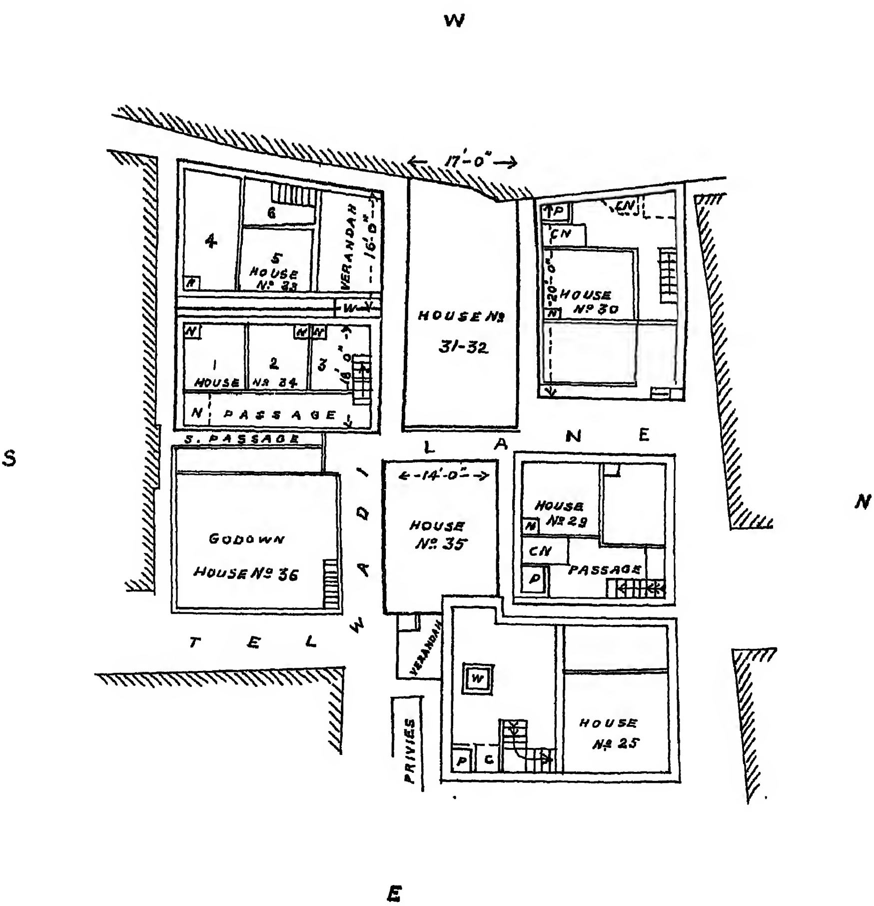
Statement giving the amounts of betterment rate leviable in respect of the properties adjoining the obstrutcive house.

Street Nos. of properties adjoining the obstructive house.	Height of buildings.	Length of frontages of properties referred to in column (1) on site of obstructive building.	Lump sum contribution recoverable from the owners in proportion to length of frontages in column (3).	30 year's annual betterment rate leviable in lieu of lump sum contribution.	25 per cent. of 9/10ths of gross assesment.	Actual general tax in 1912-1913=10⅝ per cent of 9/10ths of gross assessment.	Limit of betterment rate in 1912-1.13=column 6—column 7.
1	2	3	4	5	6	7	8
	Feet.	Feet.	Rs.	Rs.	Rs.	Rs.	Rs.
30	45	29	1,712	103	250	106	144
33	33	16	944	56	183	78	105
34	25	18	1,063	64	131	56	75
35	21	14	827	50	114	49	65
1	15	17	1,004	60	135 (Estimated).	57	78
Total ...		94	5,550	333	813	346	467

PLAN RELATING TO STATEMENT A.

TELWADI SCHEME.

SCALE, 20"–1'.



STATEMENT B.

Telwadi.

Particulars of the obstructive house. Street No. 21. Gross annual assessment Rs. 653. Cost of acquisition estimated for the purposes of the following Statement at 16⅔ Y. P., on Rs. 653 plus 10 per cent. for contingencies = Rs. 12,000. Area = 100 square yards. Rate per square yard = 12,000 ÷ 100 = Rs. 120. 66 per cent. of cost to be recovered from owners = Rs. 8,000.

Statement giving the amounts of betterment rate leviable in respect of the properties adjoining the obstructive house.

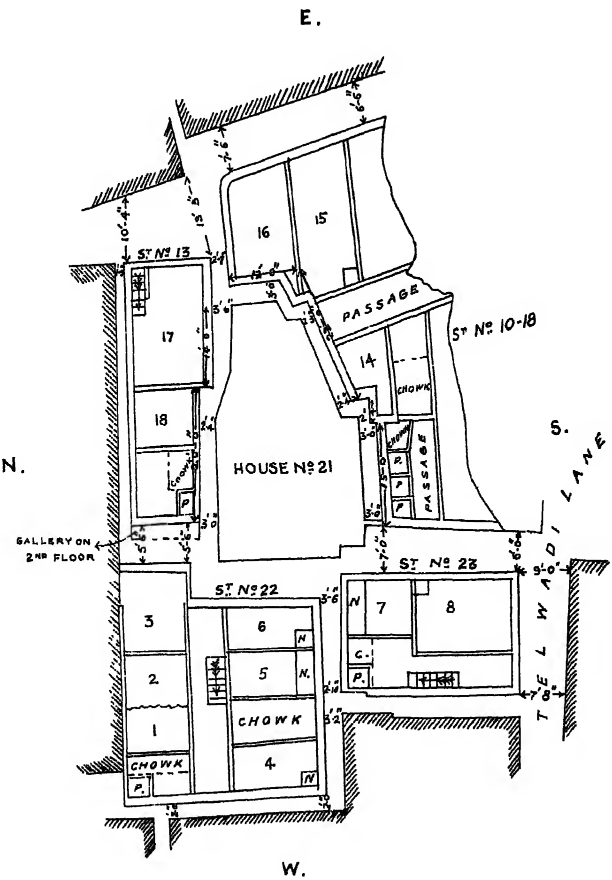
Street Nos. of properties adjoining the obstructive house.	Height of Buildings.	Length of frontages of properties referred to in column (1) on site of obstructive building.	Lump sum contribution recoverable from the owners in proportion to length of frontages in column (3).	30 years' annual betterment rate leviable in lieu of lump sum contribution.	25 % of 9/10ths of gross assessment.	Actual general tax in 1912-1913 = 10¾ % of 9/10ths of gross assessment.	Limit of betterment rate in 1912-1913 = column 6—column 7.
1	2	3	4	5	6	7	8.
	Feet.	Feet.	Rs.	Rs.	Rs.	Rs.	Rs.
10·18	50	15, 4, 22, 12 } 53	3,889	233	1,028	437	591
13	26	34	2,496	150	85	36	49
22	26	17	1,248	75	260	111	149
23	29	5	367	22	139	59	80
Total......	...	109	8,000	480	1,512	643	869

The betterment rate will be limited to Rs. 49 in house No. 13, so that betterment rate leviable in 1912-13 will be 233 + 49 + 75 + 22 = Rs. 379, which connotes distribution of cost of acquisition 52 per cent. to private owners and 48 per cent. to public purse.

PLAN RELATING TO STATEMENT B.

TELWADI SCHEME.

SCALE, 20' = 1".



STATEMENT C.

Kolbhatwadi.

Particulars of the obstructive house. Street No. 37. Gross annual assessment Rs. 703. Cost of acquisition estimated for the purposes of the following Statement at 16⅔ Y. P., on Rs. 703 plus 10 per cent. for contingencies = Rs. 12,900. Area = 113 square yards. Rate per square yard = 12,900 ÷ 113 = Rs. 114.

The East end of the house to a depth of two rooms may be left standing, and may be valued at *2/5 × 11,717* = Rs. 4,687, say *Rs. 4,690*, as there are five rooms on each floor. The Western main wall of the standing portion of the house and the privies will have to be constructed staircase will have to be shifted and sundry repairs will have to be carried out. The cost of carrying out this work may be roughly put down at Rs. 2,000, so that nett proceeds from the standing portion of the house may be estimated at 4,690—2,000 = 2,690, say Rs. 2,700. 60 per cent. of the remaining cost (*viz.*, 12,900—2,700 = 10,200) to be recovered from owner = Rs. 6,120 (*vide* Column 4).

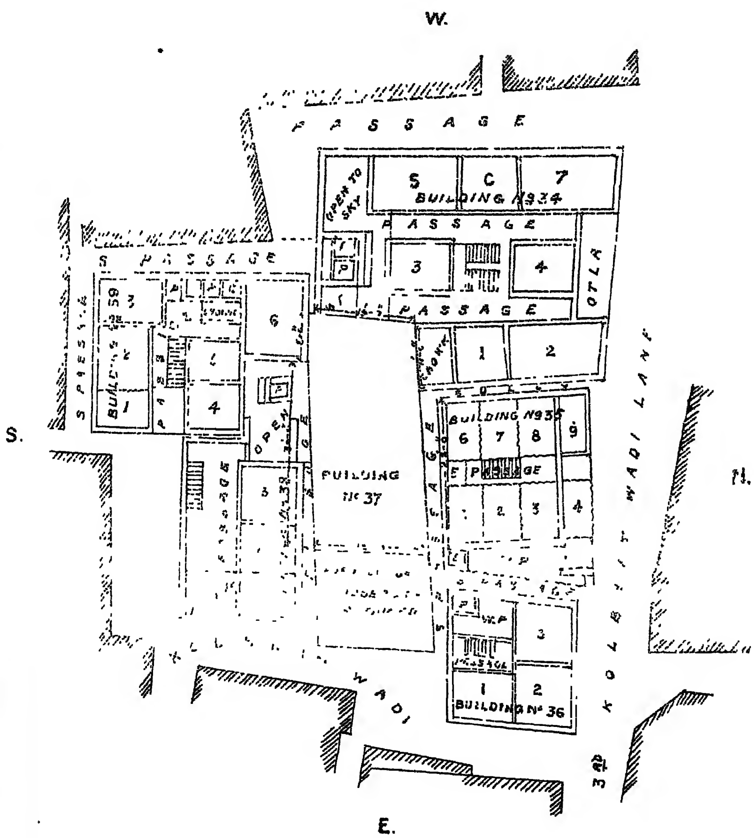
Street Nos. of properties adjoining the obstructive house.	Height of buildings.	Length of frontages of properties referred to in column (1) on site of obstructive building.	Lump sum contribution recoverable from the owners in proportion to length of frontages in column (3)	30 years' annual betterment rate leviable in lieu of lump sum contribution.	25 per cent. of 9/10ths of gross assessment.	Actual general tax in 1912-13 = 10⅝ % of 9/10ths of gross assessment.	Limit of betterment rate in 1912-13 = column 6 — column 7.
1	2	3	4	5	6	7	8
	Feet.	Feet.	Rs.	Rs.	Rs.	Rs.	Rs.
34	27	11, 19	1,611	96	295	125	170
35	26	26	1,395	84	167	71	96
38	28	30	1,611	97	127	54	73
39	27	9	483	29	218	93	125
37	28	19	1,020	61	68	29	39
Total...		114	6,120	367	807	343	464

The betterment rate will be limited to Rs. 39 in house No. 37 and to Rs. 73 in house No. 38, so that betterment rate leviable in 1912-13 will be 96 + 84 + 73 + 29 + 39 = Rs. 321, which connotes distribution of cost of acquisition 52 per cent. to private owners and 48 per cent. to public purse.

PLAN RELATING TO STATEMENT C.

KOLBHATWADI SCHEME.

SCALE, 20"=1'.



7.

STATEMENT D.

Umarkhadi.

Particulars of the obstructive house. Street No. 24. Gross annual assessment = Rs. 1,501. Cost of acquisition estimated for the purposes of the following Statement at 16⅔ Y. P., on Rs. 1,501 plus 10 per cent. for contingencies = Rs. 27,518, say Rs. 27,500. Area = 211 square yards. Rate per square yard = 27,500 ÷ 211 = Rs. 130. 66 per cent. of cost to be recovered = Rs. 18,333, say Rs. 18,300 (*vide* Column 4).

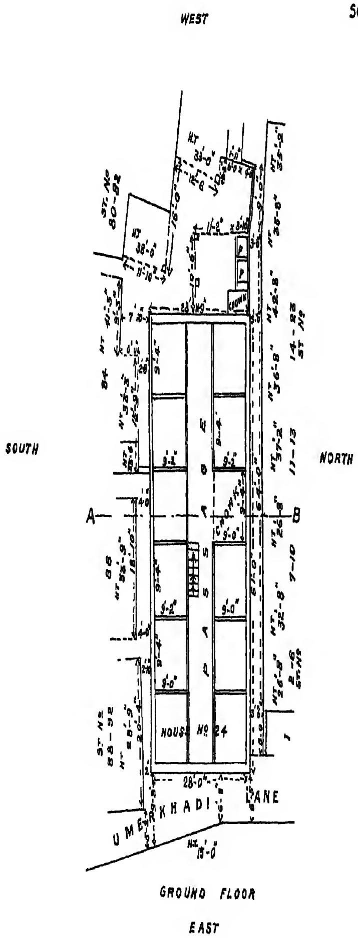
Statement giving the amounts of betterment rate leviable in respect of the properties adjoining the obstructive house :—

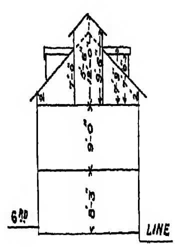
Street Nos. of properties adjoining the obstructive house.	Height of buildings.	Length of frontages of properties referred to in column (1) on site of obstructive building.	Lump sum contribution recoverable from the owners in proportion to length of frontages in column (3).	30 years' annual betterment rate leviable in lieu of lump sum contribution.	25 per cent. of 9/10ths of gross assessment	Actual general tax in 1912-1913 10⅝% of 9/10ths of gross assessment.	Limit of betterment rate in 1912 1913 = column 6—column 7
1	2	3	4	5	6	7	8
	Feet.	Feet.	Rs.	Rs.	Rs.	Rs.	Rs.
80-82	33 to 38	50	4,973	298	592	251	341
84	33 to 41	25	2,486	149	559	238	321
86	34	19	1,890	114	330	140	190
88-92	29	20	1,989	119	430	183	247
1-23	27 to 42	70	6,962	418	956	406	550
Total ...		184	18,300	1,098	2,867	1,218	1,649

PLAN RELATING TO STATEMENT D.

UMARKHADI SCHEME.

SCALE, 20'-1'





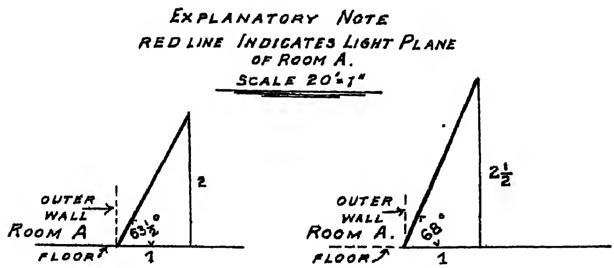
SECTION ON LINE A.B.

APPENDIX D.

ROUGH SKETCH OF THE LEGISLATIVE PROVISIONS REQUIRED TO GIVE EFFECT TO THE SUGGESTIONS IN THE MAIN NOTE, IN THE SHAPE OF A DRAFT BILL.

For the purposes of this Act the expression "Special Committee" shall mean a Committee composed of the Municipal Commissioner, Chairman, Improvement Trust, and Health Officer, Bombay, and the expression "light plane" shall mean the "plane drawn upwards and outwards from the edge of the floor of any room at an angle of 63½° to the horizon," provided that in specified localities in which the Corporation with the sanction of Government so prescribe the definition shall be read as if 68° were substituted for 63½°.

Vide note para. 13.
Vide note para. 18
Vide note para. 9.
Vide note para. 10



2. Every room shall be deemed unfit for human habitation unless it has got a window or windows opening on to a light plane which does not impinge upon any building and unless the area of such window or windows is at least equal to ½ of the area of the wall in which it or they are placed and 1/7th of the floor area of the room. *Vide* note paras. 4. and 18.

3. No building shall be constructed so as to impinge upon the light plane of any room used or capable of being used as a human habitation except with the written consent of the owners of that room. This section shall not apply to any wall, screen or hoarding lawfully erected within 12 months from the date of this Act for the purpose of preventing the creation of an easement over any property. *Vide* note para. 4.

4. After the close of the year 1917, every one who inhabits a room which is unfit for human habitation and every one who gives, lends or leases such a room for human habitation without the Special Committee's written permission, shall be liable on conviction to a fine of Rs. 200. *Vide* note paras. 5. and 6. *Vide* note para. 13

5. The Municipal Commissioner, and in areas represented under Section 24 of the Bombay City Improvement Act, the Bombay City Improvement Trust may, at any time, before the close of the year 1917, order that a room which is unfit for human habitation shall be vacated within two months, provided that he or they shall at the same time offer the tenant of the said room accommodation of the same extent and at the same or lower rent within a distance of one mile from the said room. *Vide* note para. 7.

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6. A copy of such order shall be delivered to the owner of the room and the order shall be deemed to have been communicated to the tenant by the inscription of the letters "U. H. H." on the door of the said room.

Vide note para. 5.
Vide note para. 13.

7. Anyone occupying such a room or allowing it to be occupied for human habitation after two months from the date of any such order shall be liable on conviction to a fine of Rs. 200, unless the Special Committee have in the meanwhile given written permission for the occupation of the room and have removed the letters "U. H. H." from the door.

Vide note para. 13.
Vide note paras. 11 and 12.

8. The Special Committee *shall* on the application of the owner grant such permission as soon as the room ceases to be unfit for human habitation and *may* subject to clause 14 grant it so soon as external open space of at least half the width required by this Act has been provided, and an agreement for the provision of the other half within 20 years has been executed.

Vide note para. 15.
Vide note para. 18.

9. The Municipal Commissioner and in areas represented under Sec. 24 of the Bombay City Improvement Act, the Bombay City Improvement Trust, may on the application of owners of houses assessed at half or more of the total assessment of the houses concerned acquire by procedure under the Land Acquisition Act any house which impinges on the light planes of rooms used for human habitation in two or more neighbouring houses, and after acquisition shall dispose of the acquired property in such a way as to secure for each such house a free air space above the said light planes. The order of disposal shall lay down the limits within which building on the acquired site is to be permitted, and shall be communicated to the Municipal Commissioner, who shall be responsible for seeing it strictly enforced in connection with procedure under Chapter XII of the Municipal Act.

Vide note para 17.

10. The nett loss on each such acquisition case shall be chargeable to the properties benefited thereby as the Commissioner or the Improvement Trust may direct, in rough proportion to the lengths of the frontages of the several properties upon the area cleared of buildings. The sum so chargeable shall be recoverable from the owner of the house by the Municipal Commissioner, as if it were arrears of Municipal Taxes, but may be commuted into an annual payment of 6 per cent. of the said sum for 30 years. The sum thus annually payable shall be recovered along with and as if it were part of the General Tax and all such sums recovered in any year in respect of any represented area shall be handed over to the Improvement Trust at the end of the year.

Vide note para. 16.

11. In any represented area in which in the opinion of the Trust it is desirable in public interests that the one room tenements condemned as unfit for human habitation under this Act should be rendered habitable within twelve months, the Trust may require the owner of any house which contains 5 or more such rooms to re-construct his house within 12 months in accordance with plans provided by the Trust or with plans approved by them as regards the amount of living accommodation provided.

Vide note para. 16.

12. Should the owner fail to carry out such re-construction within the 12 months or within such extended period as the Trust may allow him, the Trust shall acquire the said house under the Land Acquisition Act and carry out the re-construction themselves.

13. In any such represented area as aforesaid the Bombay City Improvement Trust may without waiting for a requisition from house owners acquire and dispose of any obstructive house which impinges on the light planes of any two or more neighbouring houses in accordance with the procedure laid down in section 9, and their nett loss in the transaction shall be recoverable in accordance with section 10, provided that in case of commutation the sum chargeable to any house in any year shall be limited to 15 per cent. of the Municipal Assessment of the house for that year and the balance shall be remitted.

Vide note para. 16.

Vide note para. 17.

14. The Special Committee shall not grant permission to any one to dwell in a room which is unfit for human habitation or to lease such a room for human habitation unless such room has at least one window satisfying section 2 of this Act in point of area and abutting upon an exterior air space open to the sky and extending horizontally across the whole width of the window to a distance from the window equal to at least one-third of the vertical distance between the top of the building on the opposite side of that space and the level of the window sill.

Vide note para. 13.

15. Subject to clause 14, the Special Committee may in cases in which they are satisfied that any room which is for the time being unfit for human habitation under clause 2 is not so seriously defective in light and ventilation that the defect cannot be temporarily condoned, grant written permission to any person to dwell in that room or let it as a dwelling, if an agreement has been executed whereby the improvement of the light and ventilation up to the full 63½° standard within 20 years is assured.

Vide note paras. 11, 12, 13.

16. A copy of every such agreement shall be supplied to the Municipal Commissioner and the Municipal Commissioner shall have power to order the closure of any house in respect of which any such agreement may not have been fully carried out, until it is fully carried out.

17. It shall be unlawful to recover any rent or other consideration for the occupation as a dwelling of any room that is unfit for human habitation unless the Special Committee have issued a written permit for its occupation as a dwelling.

Vide note paras. 3 and 20.

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

A NOTE ON TOWN-PLANNING AND TOWN-IMPROVEMENT

BY

The Hon'ble Rai Ganga Prasad Varma Bahadur.

At the present moment no question is engaging greater attention from the people of India than the appalling mortality and the high death-rate which prevails for most part of the year in Northern India, a mortality which has checked the growth of population and if not prevented will desolate large cities and throw land out of cultivation. Several agricultural industries are already suffering for want of labour. In large towns menial servants cannot be had on reasonable salaries. The Municipal bodies are finding difficulty in meeting the growing rate of labour.

2. There are economic causes responsible for the high death-rate. The question whether the people of India are growing richer or poorer may be controverted, but this fact cannot be denied that the bulk of the population do not get sufficiently nourishing food and are not physically strong enough to withstand attacks of epidemic diseases in the form of plague, or malarious fevers. The insanitary condition in which people live may be responsible for a high death-rate to a certain extent, but the fact should not be forgotten that there is a distinct change in the mode of life of the people. There is a general tendency among the people to build better ventilated houses to live in and to pay a higher rent for dwelling houses than what they were in the habit of paying a decade or two ago. There is a general tendency in the mass of the people to move towards large towns, especially where they can secure better facilities for the education of their children and better chances for securing employment. Old towns are becoming deserted. New towns are springing up. In certain old towns one part of the town at a distance from Government offices and the civil station is becoming deserted and new quarters are rising close to Government offices which attract large numbers to the detriment of the interests of the older portion of the city. These towns have not unlimited room for extension and if expansion is possible it cannot take place without State help. The problem is not an easy one. Its proper solution requires patience and resourcefulness.

3. It is a mistake to believe that town-planning was unknown to our predecessors or that the people of India did not feel the necessity of founding new towns or demolishing old houses and building new ones in their places. The injunction is to be found in the Shastras that it was the duty of the Raja to abandon and demolish towns when they were five hundred years old. The house owner was ordained to change the house when it was one hundred years old. This injunction must be due to the belief that certain diseases spring from the earth; affect a whole town and make it, for a certain period, unfit for human habitation. It is not easy to point out how far these injunctions were followed, but during certain periods of Indian history it was a common saying that with the advent of a new king new palaces are built. New towns sprang up without waiting for the demolition of old ones. When Sanitary science had not made the progress it has now made, towns and cities were established with due regard to the notions of sanitation then prevailing which we will do well to follow in these days of improved sanitation. It is true that roads and streets were not then as wide as they should have been, nor straight enough to admit fresh air freely and the people much more clustered together than what the rules of sanitation permit, but they were very particular about one or two matters. They used to keep the people carrying on objectionable trades at a distance from the bulk of the population. Every town had its " chamer tolia " or the places where tanning

was carried on. The dealers in hides and the butchers were placed outside the limits of a town, the women of ill-fame—a source of moral infection—were confined to one quarter of a city only and not allowed to roam about the whole town. The people themselves were expected to carry out certain sanitary functions, if sweeping of the house was as it is now one of the duties of the mistress of the house and the sweeping of the compound and keeping drains clean was the duty of the master of the house. Periodical cleaning of the houses from top to bottom still continues to be one of the prominent features of the life of the people. As a rule the people of India were clean in their habits, kept their houses clean and with due regard to the conditions then prevailing kept their houses in a sanitary condition and had as much regard for the free admission of sun and air in their parlours as they possibly could. Things have now however changed. The functions of the State have now devolved on the people, without the control on the financial resources of the country which is a special privilege of Royalty. The people have to adapt themselves to changed circumstances. They have given proof of their readiness and capacity for adaptability and I am sure as opportunities occur the people will fully demonstrate that they are not backward in adopting every measure which Sanitary science asks them to take as a precaution against the outbreak of disease and consequent suffering. They have to be shown the methods by which they can save themselves and their dependants from the attacks of disease and they would even at some sacrifice to themselves carry out these injunctions. Some success has been gained in this direction in the cities of Lucknow and Allahabad and other important centres of population in the United Provinces. It is the object of this paper to give an account of what has been done in my part of the country with the view that other similarly placed towns may adopt similar measures.

Aminabad Park.

4. Thanks to the initiative taken in the town improvement by the President of this Conference when Lucknow had the honour and distinction of having him as its Deputy Commissioner and Chairman of the Municipal Board, the measures of town-planning and town improvement taken by the Municipal Board of Lucknow have proved highly successful. We have so far floated four self-supporting projects, all of which have either been completed or are approaching completion. The Aminabad Park scheme was the first project taken in hand. The Park is 400 feet long and 300 feet broad, on three sides of which 52 double-storied shops have been built. For the purposes of the scheme the Municipal Board of Lucknow acquired about 9 acres of land at a cost of Rs. 1,59,649-0-0. Out of the land so acquired 3 acres were sold as sites for building the shops, referred to above. The income from this sale was Rs. 1,85,628-0-0. The money realized in excess of the cost of acquisition was spent in laying out a park in the centre, constructing roads inside the Park, building a clock-tower and constructing 52 stalls for the sale of edibles and fruits. The right to lease these stalls is farmed annually and the Board has an annual income of Rs. 3,000 from this source. This amount goes towards the maintenance of the Park and all things connected with it. The Board had to make an advance of Rs. 10,000 from its general revenues for preliminary expenses in connection with the acquisition work. This amount was paid back to the general revenues, from the amount realized from the sale of sites. Excepting the land sold as sites for shops built by private individuals on the three sides of the Park the rest of the land and all of its appurtenants are now the property of the Municipal Board. Similar results were obtained in the second scheme of the cloth market. A little over 2 acres of land was acquired for Rs. 65,802, one acre of which was sold for Rs. 75,900. The value realized over and above the cost of acquisition was spent in the making of roads in the quadrangle and a grass lawn in the centre. In the third scheme, *i.e.*, the project for a grain market with rat-proof godowns, the results have not been as highly successful financially as in the first two schemes. The Board took a loan of Rs. 80,000 from the Local Government to acquire a little over 6 acres of land, out of which 4 acres have been sold for Rs. 56,285 for building the shops. The Board has got about 2 acres of land left as its property and the sum of Rs. 23,715 left unrealized from the sale of land to make up the sum taken as a

Cloth Market.

loan for this project and which may be taken as the net prices paid by the Board for these 2 acres, as an investment, which will be a permanent source of income after the market is established. A portion of this land will be set apart as a stand for the grain carts and pack-animals. By farming the lease of this ground the Municipal Board hopes to get back full valuation for the money invested. At a very little cost the Municipal Board has launched the scheme of establishing a vegetable market and a grass market for the Eastern portion of the town with sufficient space to accommodate the large number of people who generally visit such markets. Both of these markets in the course of time are likely to prove a permanent source of revenue.

Vegetable market.

5. The Government of the United Provinces has been pleased to place Rs. $3\frac{1}{2}$ lacs at the disposal of the Board for the construction of Sanitary roads in the city. The Board has so far acquired 40 acres of land at a cost of Rs. 4,63,208 and has sold sites for houses and shops along the new roads for Rs. 1,74,212. It has in its hand sites which are likely to fetch Rs. 2 lacs more. The total length of the new roads to be constructed will be about 7 miles, and so the cost will not be more than Rs. 50,000 per mile. Three sections of the Sanitary Road have already been constructed and in the 3rd section a large portion of the land acquired, which was not required for the road, has been set apart for a park a little larger than the Aminabad Park.

6. The most important project of town-planning undertaken by the Lucknow Municipal Board is known as the Butlerganj scheme, named after the President of this Conference. Although the scheme was initiated by him, it had to be carried out after his departure from Lucknow by the Improvement Trust Committee of the Lucknow Municipal Board. This scheme consisted of acquiring a large piece of land containing a number of houses *kacha* and *pucca* and groves of fruit trees lying on the outskirts of the present Civil Station. This ground, it was proposed, was to be marked off with sites for constructing dwelling houses and by the sale of these sites and the consequent construction of new buildings thereon the present Civil Station would be extended. The Board had to acquire 260 acres of land for this purpose and to carry out this scheme had to take a loan of Rs. 1,75,000 from the Government. Out of the land so acquired 70 acres of land have already been sold for a total sum of Rs. 88,310. It is estimated that from the sale of the remaining sites for houses Rs. 50,000 will be more realized. In continuation of the land acquired by the Board was lying a piece of land which belonged to the State and which was hitherto given on low rent for cultivation purposes. The whole of the land, both Municipal and State, was included in one project. Five roads, sixty feet wide and five lanes fifteen feet broad, have been newly constructed at suitable distances inside this area and water mains have been laid thereon. All this has cost the Board Rs. 2 lacs. Besides the State owned property the Government has in this scheme reserved some land for State purposes. It has therefore contributed Rs. 89,000 partly as the price of land so reserved and partly on account of the improvement caused by the carrying out of this scheme to the land owned by the State.

7. These schemes necessitated the dehousing of a large population. At the commencement of this scheme it was not thought necessary to found bastis or new quarters for the dehoused population. But in the latter stages, specially when the scheme of Butlerganj was taken in hand and a large population had to be moved from one quarter of the town and since the population consisted of men who were in the employment of persons living in the Civil Lines, a small basti for housing these men had to be established. A piece of land owned by the State was lying near at hand at a distance of 2 furlongs from Butlerganj on which a model basti was established. About 40 acres of land was utilized for this purpose and a sanitary basti was laid out with sites marked off to enable the poorer class of people who had to vacate their houses to construct new buildings thereon. The State land has been given to these people on thirty years' leases at the rate of Rs. 10 per bigha or Rs. 15 per acre and at the rate of Rs. 38 per acre to outsiders. The lease of these sites was eagerly taken up by

the people ejected from the land required for the extension of Civil Lines and in the course of the last two years a basti consisting of both *pucca* and *kacha* houses sprang up. The Municipality has laid a water main on the roads of this basti and proposes to metal at an early date the principal roads in it, which are all 60 feet wide. In the centre of the basti a large piece of open ground measuring 2 acres has been set apart for a play ground for the children and a market for the people of the basti respectively. People occupying the houses in this new basti in spite of the inconvenience to which they were put in vacating their old dwelling houses and building new ones are feeling happy and contented. This basti has been named Boasganj after the late Mr. Boas, the then Deputy Commissioner and Chairman, Municipal Board of Lucknow.

8. The Municipal Board to prevent overcrowding of the mohalas in the city has taken further steps to found a model Sanitary Basti in the very heart of the town to supply sites for building houses on approved model plans for the poorer class of people. The Board acquired 10 acres of land at a cost of Rs. 33,772 for this purpose and spent Rs. 19,974 on levelling land, road making and laying on water for this basti. The land was divided into several groups of sites to suit the different class of model houses. The Board spent a further sum of Rs. 10,000 in building houses of every model in order that people should follow the example set by the Board. In order to demonstrate that the owners can get full value for the money invested, the Board sold a number of the model houses constructed by it and secured fair prices. All the sites have been sold and fetched a total amount of Rs. 23,000 as their prices. The loss sustained in this scheme will be met from the grant of Rs. 37,000 made by the Government for the carrying out of the scheme. After the whole transaction is over enough funds will be left in hand to repeat this scheme in another part of the town.

9. The question which has often caused perplexity to the towns in which Government land has been included in a town-planning project has been as to whether the sites for building houses should be given only on long leases or sold outright. In the United Provinces we have had experience of both schemes. In the Georgetown, Allahabad, which is situated in one of the best localities of the town, in close proximity of Government House and Alfred Park, sites of 2 acres each were offered for lease at Rs. 20 per bigha on a fixed minimum premium. These sites did not get a sufficient number of purchasers. On the other hand in Lucknow for every 2 acres site in the Butlerganj scheme there was good competition and fifty sites have been so far sold at an average price of Rs. 1,500 per acre; the reason being that people prefer to purchase free-hold land in order to avoid liability of annual rent being revised every 20 or 30 years. People should be encouraged to purchase free-hold land, but where this be not possible the term of the lease should be for ninety-nine years.

10. In opening out congested areas the question often arises as to how much land should be acquired by a local body, *i.e.*, only as much as is required actually for making a road or it should acquire land sufficient both for the frontages of new houses and the road. We had experience of both of these methods in Lucknow. In constructing the La Touche Road the Government acquired only as much land as was necessary for the construction of the road, with the result that property on both sides of the road rose in valuation and the people owning property on the roadside earned quite a lakh of rupees without spending a single pie on its improvement. What is worse, there are still some huts on this broad road, the owners of which are being offered fancy prices but are not yet willing to part with them. These huts are mostly in an insanitary condition and are an eye-sore to the locality. On the other hand on the Hewett Road, which is still under construction, the Board has so far received Rs. 1,74,212 by the sale of sites along the road. This amount of money has gone a great way to relieve the Municipal Board of the cost of the scheme and buildings have been constructed according to approved plans, which have added to the beauty of the road and increased house accommodation. It is said that when an Act of Legislature on town-planning is passed, as it will be necessary to do at an early date, the Boards may be empowered to levy a rate on unearned increment within a certain radius. Any such rate will be highly unpopular with the mass of the Indian people. They will be unwilling to pay the rate on their property merely for the fact that a new road had been constructed near their houses or that

certain congested areas had been opened up at some distance from their residences. For the present the local bodies should be permitted to acquire sufficient land over and above what is required for constructing the roads to allow of the sale of sites for building houses or shops of an approved pattern in order to ensure good frontages.

11. From the above short description of several town improvement schemes it would appear that Lucknow had been exceptionally fortunate in all its schemes of town improvement and town-planning. It has been so because the schemes met with public approval. From their very inception complete harmony prevailed between the official and non-official members of the Board and complete confidence was shown in the people who co-operated with the Board in making them successful. It is not true that the people always become suspicious of the motives of the authors of town improvement schemes. They do so when they find that they are not taken into confidence and things are done over their heads. In the very conception and carrying out of large schemes the people should be consulted at every stage of the progress of the scheme. The. work of land acquisition is a most difficult one. The greatest care should be taken in selecting officers entrusted with the Land acquisition work, who should have under them subordinates of approved honesty. It should be seen that the intentions of the Legislature are religiously carried out and that the man who is dispossessed of his property gets its full price and is paid 15 per cent over and above it for compulsory acquisition. Before referring cases to the Civil Court, I would like to see doubtful cases referred to a body of assessors, care should also be taken to see that no partiality is shown to rich and influential persons. Both rich and poor should receive equal treatment. If a house or land is to be acquired on the frontage of a road it should be on some public ground. Much opposition to compulsory acquisition is disarmed by the Municipal Board carrying public opinion with it.

12. The second point which deserves consideration is that every effort should be made to seek the co-operation of the people. This can best be done by fully convincing the citizens that the Board does not desire to make any profit out of the schemes and that it is rather prepared to lose if necessary on town improvement schemes. In launching new schemes the local body should be prepared to spend its own funds on making roads, completing drainage and laying on water mains. In every town there are well-to-do persons who are willing to perpetuate memory of their relations by philanthropic deeds. They will willingly contribute towards the construction of a road if it be named after them. They will give money for putting up fountains and drinking troughs for cattle. This spirit has to be encouraged. Philanthropical persons may also be persuaded by grants of land on cheap terms to found new mohalas. Capitalists may be persuaded to find money for building sanitary houses and to be content with small returns. My belief is that the question of town improvement has not been so far taken in the spirit it should have been. No Government can command resources to construct new towns in place of old ones, wholesale demolition of old houses is impossible, but the Government of India can encourage Municipalities by grants towards completing well-thought-out schemes. It can allow philanthropical societies the use of its credit by advancing large sums of money as *takavi* for the construction of new buildings. With the little experience of town improvement schemes in Lucknow, and the results achieved in Georgetown, Allahabad, of the eagerness with which the people of congested towns like Benares and Cawnpur are expecting the repetition of schemes like those of Lucknow in their towns, I can safely say that as far as the United Provinces are concerned—for every rupee spent by the Government in housing the people in sanitary buildings in model bastis people themselves are willing to put in Rs. ten. The Government of the United Provinces made a grant of Rs. 3½ lacs to Lucknow for sanitary roads and granted a loan of Rs. 2 lacs for 2 projects. The loan has been paid back to the Government. The people have spent about rupees ten lacs of their own in purchasing lands and building houses thereon according to the plans approved by the Municipal Board. What has been achieved in Lucknow can be achieved in any other similarly situated town, if once the State realises its duty to help the people, who desire to help themselves and make sufficiently large contributions towards well-thought-out sanitary projects. All the sacrifice made in money and time will end in a return beyond the most sanguine expectations.

Notes on building bye-laws.

NOTWITHSTANDING Professor Karl Pearson's statistically proved theory that heredity has a greater influence on the health of children than the substitution of feeding by bottles for breast feeding or the residence in back to back tenements as compared with houses with through ventilation, the majority of sanitarians from analogy with plants and animals, still believe that light, thorough ventilation, and healthy surroundings have a very great influence on the health not only of children, but also of adults. The florist has shown us, what an enormous difference can be produced in chrysanthemum flowers by proper environments, by manuring and by constant care and attention, and anyone having dealings with animals will acknowledge how fatal is overcrowding and bad air on the health of even the best stock.

The Local Governments in India have within the last few years been awakened by the high death-rates in the municipalities to the necessity of taking some action for the provision of light and perflation of air, and have provided passage to air currents, by cutting broad roads through congested areas, hoping thereby to effect a reduction in such mortality. In this laudable intention they have in some towns signally failed for the following reasons :—

(1) That often little or no provision has been made for the housing of the displaced population; and the overcrowding in the areas abutting on the broad road has consequently increased;

(2) That the provision of light and air to the individual by dealing with his housing has not received sufficient attention.

We have been accustomed to look on sanitation as a general measure for communities, and have lost sight of the fact that the individual is of the first importance. For an efficient army every unit must be carefully and thoroughly trained on the range and on the parade ground. In all collective competitions of skill it is the training and health of the unit that secures the prize. In disease it is the unit that introduces cholera and spreads it to others, and it is the unit of tuberculosis in a family that acts likewise. If we are to gain any good by a tuberculosis campaign it is to the housing and surroundings of the individual that our attention must be directed as the prophylactic measure most likely to succeed in dealing with this fell disease. This great fact has not been brought into prominence. General sanitation, that is, the provision of town water-supplies and drainage and of the cutting of broad roads through congested areas are the foundations to our building of the national health. It is now time that every individual stone in the edifice should be carefully dealt with. A nation's greatest asset is its health and its births. Its health depends on that of the individuals of which it is composed and its birth-rate usually follows its health curve. In a community in which we have good health, wealth follows as natural sequence.

It is with the desire to improve the surroundings of the individual that building bye-laws have been constructed, but to the Sanitary department it has been heart-rending to see, how even the local authorities have been loath to enforce necessary bye-laws. In Cawnpore after certain bye-laws had been passed by the Local Government on the attempt to enforce them some members of the Municipal Board brought forward reasons why they should not be applied in an individual case, thus stultifying the whole of the good that was intended. The reasons for the necessity of bye-laws have been largely misunderstood by nearly all classes, but especially by the Indian members of the community. They have been considered as measures of oppression instead of what they are in reality; measures of protection for the poor against the rapacity of the landlord and the insurance for them of healthy dwellings.

Bye-laws are simply enactments in municipalities and towns to deal with the varying local conditions and are based on acts passed by the Local Government. Building bye-laws are an endeavour to ensure to every dweller in towns light, air and healthy surroundings in his home. Light and air are heaven's free gifts which

require no pipes or water rates for their supply. It is only man's stupidity and greed that has stolen from the poor this birth right. Bye-laws are therefore not acts of oppression but acts for the restoration to the individuals of a community of their lawful birth right. For example, in bye-laws the height of the houses is regulated to prevent one man from appropriating the light and air to which his neighbour is entitled and although building in certain ways is restricted, it is only when these methods are inimical to health. As the nation's health is dependent on that of its individuals, the officers with special Sanitary knowledge, in whose hands the building up of national health is placed, should have the right of protection of the individual against his own folly produced by want of knowledge, and a still greater right to restrict his actions when they result in injury to his neighbour. It is for this reason that the Sanitarian cries out for the provision of good bye-laws and cannot be held responsible for the failure of general sanitary measures to produce a marked reduction in the death-rate of towns in which these laws are a dead letter or are not enforced with energy and vigour. Building bye-laws to be of use must be all-embracing and must deal with every factor that might prove injurious to health. It is the non-observance of details that brings sanitation into disrepute. The infliction of small non-deterrent fines for the non-observance of these laws is a mistake and although there is no shadow of doubt that it is of great advantage to have the general feeling of the community in accord with the improvements, our society is unfortunately not as yet sufficiently educated in sanitary matters to appreciate the necessity for, and importance of, these laws.

Let us now examine building bye-laws in detail. As there is no town planning act, at present in existence, in India, by which the foundations of the sanitation of a town can be laid down; in this paper we will deal only with bye-laws in reference to existing conditions treating of things as they are; of narrow streets and high houses and the defective light and perflation, and not of things as they should be. Model bye-laws are therefore not *model* in the strict sense of the word, as we have to be content with the minimum space allowable having regard to the expense of building alterations and of the land values. These points do not require such deep considerations in town planning when the town is as yet unbuilt and where better sanitary conditions can be insisted on without involving excessive cost.

Our endeavour with the existing towns is firstly to ensure light and good ventilation in all rooms and to eliminate those unfit for human habitation, and by the regulation of the erection and re-erection of houses to produce in the course of time an improvement of the whole town. A more rapid but expensive way of improvement is by the acquisition of whole blocks and by building sanitary houses on these areas. These methods will be more fully dealt with in other papers during the conference.

Building bye-laws deal therefore with—

(*a*) Buildings for human habitation;

(*b*) Buildings for warehouses, factories, &c.

(*c*) Buildings for public use, such as theatres;

(*d*) The construction of markets, dairies, &c.

Factories and building of the warehouse class, should, when possible, be relegated to a section of the city by themselves. We shall not have time to go into the question of special bye-laws for these edifices.

To-day we are concerned with bye-laws for the erection and re-erection of buildings for human habitation.

These may be divided under the following headings:—

(I) Bye-laws for the regulation of the site on which houses may be erected and the amount of the site which is allowed to be built over.

(II) Bye-laws for the regulation of the house in relation to its neighbour with a view to obtaining light, air, and perflation.

(III) Bye-laws regulating the internal economy of the house and for the provision of light and air in all rooms.

(IV) Bye-laws regulating the situation of the bath rooms, lavatories, latrines and cook-houses in relation to each other and to the living room, and also the removal of excreta and sullage.

(V) Bye-laws for the construction of houses in relation to stability and the prevention of dampness.

(VI) Regulations in case of fire, for the provision of sufficient exit and for fire-proof staircases.

1. *The regulation of the site.*

A. Physical characters.

B. Area of plots for varying types of inhabitants.

C. Area of site to be covered by buildings.

A. The physical character of the site.

No piece of land shall be used as a site for the erection of a building—

(*a*) If the building is to abut a street, unless the site is of such a shape that the building can be made parallel to the line of the street.

(*b*) If the site is on tanks or creeks filled up with, or used for depositing, rubbish, offensive matter, or sewage, unless such site has been certified by the health officer and the Municipal Engineer as fit to be built on.

(*c*) On any ground unless the site is certified by the health officer to be dry and well drained or capable of being well drained.

The site must also not be on a lower level than will allow its drainage to be led into some existing or projected sewer.

(*d*) If situated within 30 feet of a tank unless the owner can prevent risk of contamination of the tank by his domestic drainage.

No building can be erected over a municipal drain.

B. The area of the site to be allotted for varying types of inhabitants.

The author does not agree with Mr. Unwin that the poor and the rich should be sandwiched together. In taking up congested areas, or town extension, the type of people to occupy the blocks is an important consideration. In the new town of Ballia the depth of each building plot was fixed at 82 feet under the impression that the front part of the house would be taken up by the shop or inhabited by the male members of the family. The female members would occupy the back part of the house and the central one-third would remain an open courtyard. What in reality took place was that the people were too poor to follow out this idea, the front and back blocks were built, but the back block was sublet with the result that streets are in process of formation facing conservancy lanes—an effect the opposite of what was intended. These consequences are largely due to the want of good building bye-laws regulating the relation of one house with its neighbour.

On the inspection of the various types of plans of model houses constructed by the Public Works department for various classes of community, it will be seen that the areas covered by these houses must be dissimilar and consequently the site must be different for the different types of houses.

There are five main types of houses in the model plans constructed by the Public Works department—

I and II E and E for the poor people.

III Type A.

IV Type B.

V Type C.

Only in Type I are contiguous houses dealt with, although Type A with slight modifications could be made to suit the contiguous method of erection.

Type I. The site is 40′ × 12′. The total area of the site is 480′. The area covered by building is 252′. This leaves ample space for air.

Type II E. The site is 32′ 7½″ × 14′. Total area 456¾′. Total area covered by building 333′. These attached houses do not therefore comply strictly with the bye-law.

Type III A.—The site is 33′ 1½″ × 21′ 4½″. Total area of house is 708.′ Total area covered by building is 459¼′. Therefore fully ⅓ of the area has not been built over.

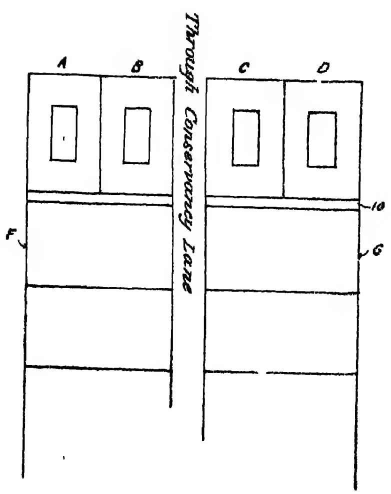
Type IV B.—The site is 51′ 9″ by 27′ 4½″. The total area of the site is 1,417′. Total area covered by building is 1,099′. More than two-thirds of this area has been built over but as the building is constructed for a semi-detached house, 6 feet if left unbuilt over along one side will give the required space.

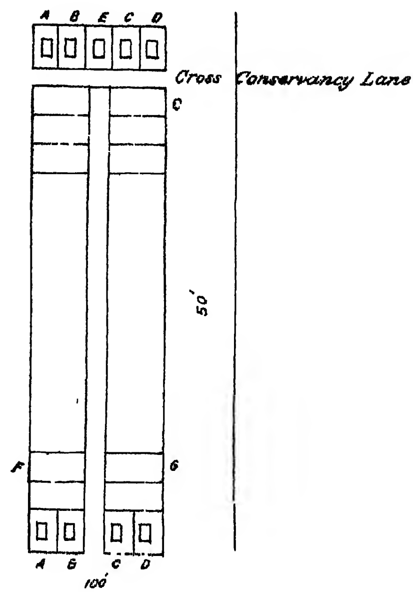
Type V C.—Is a large detached house with a central courtyard. The site is 50′ 1½″×37′ 6″. Total area 1,880′. Area covered by building 1,336′. Though this is well within the ⅔ rate, space on each side for the lighting of the side rooms would be required. From the above it will be seen how necessary it is to lay down a site area to be occupied by each type or types of houses.

Further, sites which are too small for the erection of sanitary buildings will have to be acquired by the municipality and either sold to the neighbour or retained by the municipality for children's play-grounds, for the erection of fire brigade stations, or for storesheds, &c., as suggested by Mr. Orr, I.C.S. In Mandalay the owners of plots of two kans or 14 feet of frontage with a depth of 60 or 80 feet applied for permission to build over this area. The erection of building of this class could not be permitted and yet with no existing scheme for the acquirement of the land, it appeared to be an injustice to refuse permission for the erection of houses on land which might be the only source of income to the owner.

C. Not more than ⅔ of the area of the site should be built over. The working of this rule requires careful supervision, as the ⅓ area which must not be built over includes (1) the space at the back of the house to which reference will be made subsequently, (2) the central courtyard where this is existent, and (3) in semi-detached houses the area left between the houses.

In Rangoon where the new blocks are laid out as rectangular parallelograms, between streets 80 to 100 feet wide, with a cross road 50 feet wide and with central conservancy lane 15 to 20 feet wide, building sites facing roads 80 to 100 feet wide are known as first class building lots. These lots are largely taken up by rich Chinamen whose houses are all constructed on the central courtyard type. The following diagrams illustrate the state of affairs in this town. The drainage as carried out by the Shone Ault system is installed down the conservancy lanes. It follows that the drainage of houses A and D must be carried under B, C or F and G to reach the drain in the conservancy lane, as the erection of detached buildings is not encouraged.





To avoid this the alternative measures are either to have cross conservancy lanes at each end of the block behind the first class lots or to compel the owners to leave an unbuilt-over space of 10 feet between their houses and houses F and G. In both methods the drainage is not carried under houses and through ventilation is assured. This 10 feet space is included in the $\frac{1}{3}$ area over which building is not permitted.

B. The relation of the house to its neighbour. This section is divided into—

(a) Space in front of the building.

(b) Space at the back.

(c) Relation of the sides of the house to the adjoining tenements.

(a) The relation of a house to its *vis-à-vis* by a building angle of 45 degrees is excellent for new towns. The 45 degree angle means that the house is not to exceed in height the width of the street facing the site. An angle of 56 degrees is more generally adopted for re-erections in existing towns, the height in these cases is limited to 36 feet and in no case must the building be higher than was originally at the passing of the Act standing in the same place. If however the building or one or more of its storeys be set back from the outer boundary of the site, the height of the building may be increased subject to the condition that no part of the building intersects any of the aforesaid lines. The difficulties experienced are in narrow streets of 10 or 20 feet wide such as exist in Cawnpore and in many other towns. In these areas the erection of double-storied houses should be prohibited and where funds are available these areas should be acquired and laid out by a town planning scheme, the erection of new houses on this area to be carefully supervised by the municipality. The difficulties met with in carrying out this method of improvement are generally that funds are not available and municipalities too poor to adopt these measures. The plotting system as recommended in G. G. O no. 1345/1354 of 26th July 1912, is excellent for adoption in these cases.

The height of masonry buildings is regulated as follows :—

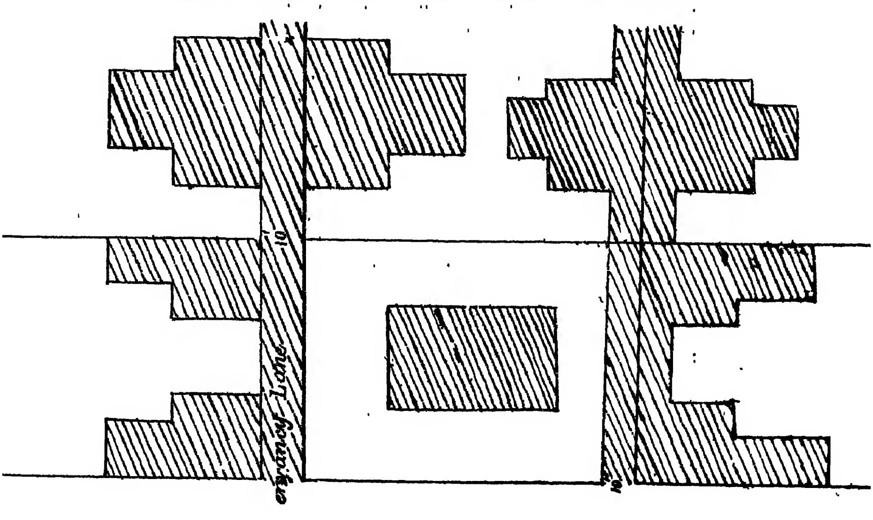
In streets not less than 30 feet width	...	... Three storeys.
Do. do. 50 ,, do.	...	. Four ,,
Do. wider than 50 ,,	..	.. Six ,,

(b) Space at the back of the house.

Except in localities where the erection of only detached building is allowed there must be in rear of every building an open space extending along the entire width of the building and belonging exclusively to the building. The building angle at the back of the house should be 56 or $63\frac{1}{2}$ degrees.

2. The questions that require decision are—

(1) In cases in which the alignment of the back of the house is irregular from what points should the line be drawn to form this angle ?



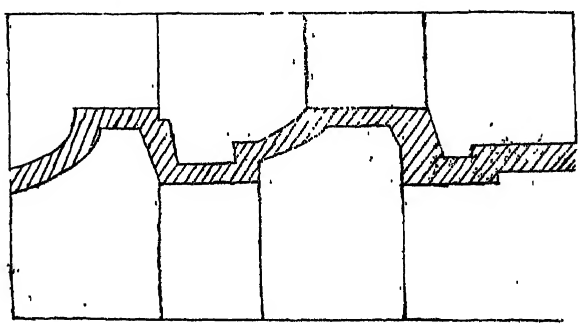
(2) and, secondly, should the back conservancy lane, where existing, be included in the one-third area of the site which is not allowed to be built on?

To answer question (1) it is best to insist that the angle should be taken from the back part of the main building and to further provide for a sufficient space between the wings of the opposite building, the minimum distance across such space from any part of the building to the boundary line of the land immediately opposite shall be 10 feet.

To answer question (2) in some places where land is expensive the centre of the conservancy lane when 15 to 20 feet wide is taken as the boundary of the opposite site. When there is an inner and outer courtyard the space between the back of the building and the boundaries of land or building opposite should be 6 feet.

To prevent the erection of houses back to back a fault which is exceedingly common where the house consists of rooms built round a central courtyard it is always desirable to have a conservancy lane in the centre of the block. Where houses are in existence at the time a conservancy lane is being made, this lane must be constructed as straight as possible, irregularities and angles annul a large part of its use.

Air in motion meeting an obstacle such as a house does not *reacquire* its motion for a distance of 1 to 3 times the height of the house. A lane as depicted in the diagram gives little perflation. The cost of making the lanes through areas largely built over is often very large.



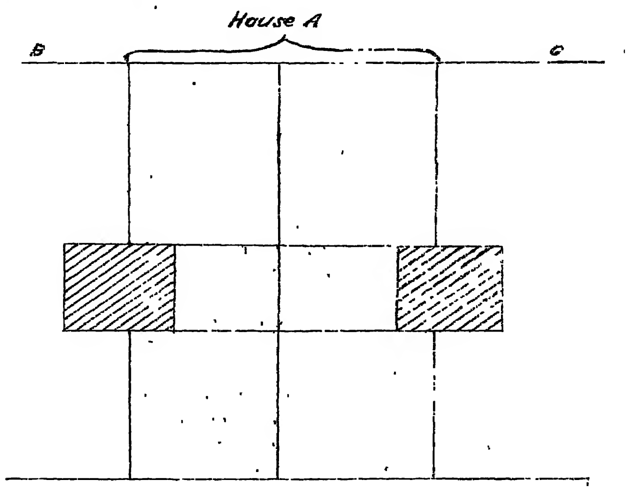
(c) In areas in which the erection of detached or semi-detached houses is allowed, the difficulty experienced is to obtain sufficient space between the houses to allow sunlight to enter the side rooms. Generally these spaces are narrow and dirty. But if there is no conservancy lane through the block there is no method of removal of excreta except through the house (a system that is common in Mandalay) and the side drainage space becomes a necessity. In Rangoon where the back conservancy lane is insisted on the Municipal Engineers are inclined to favour contiguous housing and to do away with the side spaces which must be included in the one-third area of the site which is not allowed to be built over. Where the frontage of the site is small, to insist on these side spaces renders building on the area impossible. For instance with a frontage of 25 feet if four feet were left on each side between the houses and the boundary line of the property and if three feet are allowed for the thickness of the walls, it is only possible to construct one room 15 feet wide or two rooms 7 feet wide on this area. Theoretically this space should be subject to the 63½ degrees rule but the bye-law usually enforced in areas in which detached houses may be erected is that on the re-erection of a house 6 feet [Calcutta bye-laws 24 (2)] must be left between the houses. In other towns 3 to 5 feet must be left between the houses and the boundary of the site; the owner of the next house must on re-building

do likewise. This method for the improvement of ventilation and light in rooms facing these side spaces will take years to accomplish, and may give rise to conditions in which a three or four storied house with rooms facing a space of 4 feet in width will be erected, and will remain for years awaiting the full space of 8 or 10 feet which will be obtained when the neighbouring house is re-erected. In the meantime light will penetrate with difficulty in o the lower rooms and insanitary conditions will exist for long periods. It is here again that we require pressure to be brought to improve these dark ill-ventilated rooms. In these cases also the methods for improvement put forward in Mr. Orr's proposals are admirably suited.

After ensuring that a house does not prevent the entrance of light and air to its neighbour; we will now turn and deal with the individual comfort and health of the occupant of the house. In arranging for the neighbours we have ensured light and air in the front and back rooms and to a certain extent in the side rooms. In dealing with the rooms in the interior of the house; if the house is contiguous on both sides with its neighbours, it is at once seen that the depth of the house must be limited or the central rooms would be perfectly dark. Suppose the house is 23 feet wide including 3 feet for thickness of the walls and 45 feet in length. It possesses a covered verandah 5 feet in width in the front of the house, the length of the front and back rooms is 20 feet and no other room can be introduced in a lower storey to which light and air can have access (except by a central open courtyard).

The following bye-law to prevent the formation of such dark rooms has been introduced.

The depth of no building shall be greater than double the frontage subject to a maximum of 45 feet unless every storey of such building is provided with lateral windows opening into the external air having a window area of not less than one-fourth of the floor area of such storey in addition to windows of a similar size in the front and rear of every storey.



3. If it is desired to erect a house round an open courtyard the latter part of the above rule applies, and the following rules prevent the construction of a narrow shaft down the centre of the house into which sunlight could not enter.

(a) The interior courtyard of a dwelling house must have superficial area of one quarter of the aggregate floor area of the rooms and verandahs abutting on the courtyard and having windows thereon.

(*b*) The minimum width of every such courtyard shall be 8 feet.

(*c*) No portion of any face of a dwelling house abutting on such courtyard shall intersect any of a series of imaginary lines drawn across the courtyard from the opposite face of the house at the level of the plinth at an angle of 63½ degrees with the horizontal. The storeys above the 2nd should not be taken into account in the application of this rule, if they are built on not more than two sides of the house, such two sides to be in the north and either the east or west.

The courtyard must be kept open to the sky and no structure should be erected over this open space except iron bars to protect depredations of the monkeys. The only erection allowed in the courtyard is a privy to which we shall refer later.

We will now proceed into the interior of the house and commence to deal with it by storeys. It is well known that for ventilation purposes 13 feet may be taken as the limit of the height of a room.

The height of the storeys is regulated so that in the lower storey the maximum amount of air possible is available to counteract the deficiency of air movement.

First storey	..	..	..	13 feet.
Second ,,	..	..	..	12 ,,
Third ,,	..	..	..	12 ,,
Fourth ,,	..	..	..	10 ,,
Fifth ,,	..	..	..	10 ,,

It has been found that lodging house keepers and tenants desirous of increasing their income divide these storeys into two parts. A bye-law has been introduced to prohibit this, by stating that any horizontal division of a building so constructed as to be capable of use as a living or sleeping apartment shall be considered as a storey although such division does not extend over the whole depth or width of the building.

In the individual room, in arranging for air space, ventilation and light the following bye-laws must be enforced:—

(*a*) The height of a room intended for habitation shall not be less than 10 feet measured from the floor to the under-side of wall plate or post plate or from the floor to lower side of floor joists if there is a room above.

(*b*) The room shall have a clear superficial area of not less than 96 square feet. This allows of its occupancy by a married couple and one child with a fair amount of cubical air space. In Calcutta 80 square feet is the minimum permitted.

(*c*) To ensure good lighting windows or iron barred apertures should be constructed of an area of at least one-eighth of the floor space.

(*d*) For ventilation the room shall have doors or windows opening directly into the external air, or into an open verandah, having an aggregate opening of not less than one-fourth of the superficial area of the sides or one of those sides of the room which face or faces an open space or verandah.

(*e*) Shall have every window, door or aperture so constructed that the whole of it can be opened and so that such opening shall extend to the top of each window, door or aperture.

(*f*) When its door-way, window or aperture does not reach to within 1 foot of the ceiling or roof-tie, or when the room is not provided with a roof ventilator, shall have at least one clerestory ventilating window, at a level of not more than 1 foot below the ceiling or roof-tie and opening directly into the external air or into a verandah. In addition to such door-way, window or aperture, the area of such clerestory window, or if more than one their collective area in masonry buildings shall be not less than one-twenty-fifth of the side of the room taking into account the stability of the building, and in other buildings one-twelfth of the side of the room facing an open space or verandah. The provision of ventilation in back to back rooms other than by air shafts is most difficult.

(*g*) Rooms shall be built so that no part of them is more than 20 feet from any window, French window or aperture provided for in the above bye-law.

4. Bye-laws regulating the situation of bath rooms, latrines, cook-rooms, &c., and for the removal of excreta and sullage.

These bye-laws are intended to increase the comfort as well as the health of the inhabitants, to arrange that the drainage and removal of excreta is properly carried out and give rise to no smell.

(*a*) The open courtyard must be raised sufficiently to drain into the nearest municipal drain and should be paved with impermeable material. No drain other than a rain water drain is allowed to pass through it.

(*b*) No drain, open sewer or rain water pipe from any adjacent room or tenement may run through or under any room inhabited or occupied by human beings.

(*c*) A connected privy, not exceeding 40 square feet, may be erected in the central courtyard space, where the area is over 10′ × 16′, and such privy may have as many storeys over it as there are storeys in the house to which it belongs, each being connected with the main building by a gangway or bridge of not more than 5 feet outside width.

No served privy exceeding 11 feet in height shall be placed in the space required to be left at the back of a building nor may it be placed at a distance of less than 6 feet from any public building or any building which is, or is likely to be used as a dwelling place, and it must also be detached from the inhabited portion of the building. No water-closet, privy, latrine or refuse water pit shall be nearer than 15 feet from the cooking range.

No water-closet, privy, urinal, latrine or manhole shall in any building be situated within a room used for human habitation or as a kitchen or cook-room, or shall open directly into such room, but shall be entirely cut off therefrom by a passage ventilating directly into the open air. Provided that water-closets will be permitted in any bath-room having a floor space of not less than 64 square feet.

No pipe or drop latrine shall be placed on any upper floor of a building. *Sandases* are prohibited as well as privies under any room except a bath room.

Other bye-laws provide for access from the street for removal of night-soil, &c., without it being carried through dwelling houses and for the proper construction of bath-rooms and for connected and served privies.

One of the most excellent of these by-laws is one that provides for the placing under the seat of a receptacle for sewage of a capacity not exceeding 2 cubic feet and for fitting it beneath the platform in such a manner and position as will effectually prevent the deposit otherwise than in the receptacles or specially constructed drains of any sewage falling or thrown through the aperture of the platform. This rule is nearly every where required as buckets are placed 6 inches to 2 feet below the seats allowing urine to flow all over the floors of the latrine and erode the cement and receptacles.

This is one of the main reasons why public and private latrines where this rule is not enjoined have such a disgusting odour.

Where water-supply, sewer and house connection are existent it is important that these should not leak and should be as perfect as possible, laws have therefore been introduced to ensure the protection of the occupier from the carelessness or want of knowledge of the builder or planner.

5. Laws for the stability of structure and prevention of dampness in the walls. There is no time to go into details on these points but there is no doubt that the process of building requires supervision.

Mortar, lime concrete, and cement concrete require careful mixing and the use of good materials. In the preparation of mortar the lime must be of good quality and after mixing the mortar must be used within 24 hours. Lime concrete if not properly prepared and laid down carefully is rapidly burrowed through by rats and falls into holes, the last state of the house being worse than the first. It is very necessary,

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therefore, to lay down specifications and instructions, for the preparation and use of building materials.

The next point of great importance is the submission to the municipal authorities of site and building plans for permission for erection and re-erection of houses.

It has been hitherto generally held that these plans may be submitted very roughly. On the contrary they should embrace the following which are slight modifications of the Calcutta bye-laws.

Application for the erection or re-erection of a masonry building must be accompanied by (1) a site plan, (2) a building plan which may, if the applicant so desires, be submitted together. Every application for approval of a site for a masonry or plank building must be written on a printed form (to be supplied by the President free of charge), and must state the position of the site, the number assigned to it in the assessment book, its dimensions, and such other particulars as may be prescribed by the committee.

(2) The site plan sent with such an application must be drawn to a scale of not less than one-fiftieth of an inch to a foot, must be sent in triplicate, and must show—

(*a*) The boundaries of the site and of any contiguous land belonging to the owner thereof;

(*b*) The position of the site in relation to neighbouring streets, and the difference in level between the level of the site and a point midway between the top and bottom of the street drains ;

(*c*) The name or number of the street in which the building is proposed to be situated ;

(*d*) The position of the building, and of all other buildings (if any) which the applicant intends to erect upon his contiguous land referred to in clause (*b*) in relation to—

(i) The boundaries of the site ;

(ii) All adjacent streets, buildings and premises within a distance of forty feet of the site and of the contiguous land (if any), referred to in clause (a); and

(iii) If there is no street within a distance of forty feet of the site some existing street or some street projected under section 63, Municipal Act ;

(*e*) The means of access from the street to the building and to all other buildings (if any), which the applicant intends to erect upon his contiguous land referred to in clause (*a*) ;

(*f*) The position, and approximate height of all other buildings, within forty feet of the site.

(*g*) The position, form and dimensions of privies, urinals, bathing places, cooking places, drains, cess-pools, stables, cattle-sheds, cow-houses, wells and other appurtenances of the building ;

(*h*) Free passage or way in front of the building ;

(*i*) Space to be left about the building to secure a free circulation of air, admission of light, and access for scavenging purposes ;

(*j*) The width of the street (if any) in front, and of the street (if any) at the rear of the building ; and

(*k*) Such other particulars as may be prescribed by the General Committee.

Every application for permission to erect or re-erect a masonry or plank building must be written on a printed form (to be supplied by the President free of charge), and must state the description of the building, its dimensions and such other particulars as may be prescribed by the Committee.

3. The plan of the building and the elevations and sections accompanying such an application must be neatly and accurately drawn to a scale of not less than one-eighth of an inch to a foot, and must be sent in duplicate, and the said plan must show—

(*a*) the levels and width of the sectional thickness of the walls in each storey and of the foundation of the building;

(*b*) the level of the lowest floor of the building;

(c) the level of all courtyards and open spaces in the building or premises, and the plinth-level of building with reference to the level at the centre of the nearest street;

(d) the size of windows, doors and ventilation openings for each room on every storey; and

(e) the rise, tread, width and ventilation of staircases.

4. The specification accompanying such an application must comprise full information as to the following particulars, namely :—

(i) the materials and methods of construction to be used for external walls, party-walls, foundations, roofs, ceilings, floors, bath-rooms and kitchen-floors, fire-places and chimneys;

(ii) the manner in which roof and house drainage and the surface drainage of land will be disposed of;

(iii) the manner, if any, in which it is proposed to pave the courtyards and open spaces in the building or premises, and the slope to which the surface is to be made in each case;

(iv) the means of access that will be available to scavengers to get to served privies;

(v) the purpose for which it is intended to use the building;

(vi) if the building is intended to be used as a dwelling house for two or more families, or as a place for carrying on any trade or business in which more than twenty people may be employed, or as a place of public resort, the means of ingress and egress; and

(vii) such other particulars as may be prescribed by the Municipal Committee.

Explanation to clause (v).—If it is intended to use the building or any part thereof for any of the purposes specified in the Municipal Act or as a stable, cattle-shed or cow-shed, the fact must be expressly stated.

All information and documents which it may be found necessary to require, and all objections which it may be found necessary to make, before deciding whether a site should be approved for a masonry building, or whether permission to erect or re-erect a masonry building should be given, shall be respectively required and made in one requisition and the applicant shall be apprised thereof at the earliest possible date.

A most important rule is that all applications, on receipt by the President, will be sent to the Municipal Engineer and from thence to the Health Officer, and must bear their countersignatures before final submission to the President for approval or the contrary.

The complaint has hitherto been that the compilation of these plans is expensive. To meet the requirements of the poor the following rules have been suggested:—

A. For huts.

B. For better class houses.

C. Adoption of standard plans at a nominal fee of 2 annas.

For huts and houses other than masonry—

The whole of at least one side of every room in a hut must be an external wall or abut on a courtyard or in verandah.

Every room in a hut intended to be used as an inhabited room—

1. (a) shall be provided with a doorway of not less than 15 square feet in area;

(b) shall have a superficial area of not less than 80 square feet; and

(c) shall have a height of not less than 8 feet measure from the top of the plinth to the junction of the wall with the roof;

(d) shall have a window area of not less than one-tenth of the floor space;

(e) shall in damp areas have the floor raised on piles (for Burmah) to a distance of 4 feet above the highest level of the site. In buildings composed of bricks or sundried bricks a damp-proof course composed of bricks placed in hot tar and then covered with sand shall be inserted in the walls at the level of the upper surface of the plinth.

2. No cows or goats shall be permitted to be in huts.

3. The latrine shall be at the back of the huts outside the courtyard.

4. The courtyard, if any, of a hut shall be so raised that the upper surface shall be 1 foot above the level of the nearest street or passage and shall be drained into the nearest drain.

The width of such courtyard shall be not less than 8 feet.

Every application for permission to erect or re-erect huts or houses, either cooly lines or otherwise, shall be written on a printed form which shall be supplied by the President free of charge.

If it is intended to use the hut or any part thereof for any of the purposes specified in the Municipal Act, or as a stable, cattle-shed or cow-house, the fact must be expressly stated in the said application.

The site-plan sent with such an application shall be drawn to a scale of not less than one-eighth of an inch to a foot, shall be sent in triplicate and shall show —

(i) the hut;

(ii) the privy provided or to be provided for the use of occupants of the hut;

(iii) the means of access to the hut from the street or passage on which it shuts;

(iv) the position of the hut in relation to all huts, streets, passages, privies, and tanks within a distance of 50 feet from the site;

(v) the position of cooking and bathing places;

(vi) such other particulars as may be prescribed by the Committee.

B—Every applicant for approval of a site for a house other than masonry, or a hut, or a plank building of the brick-nogging type must submit—

(i) a site plan in conformity with rule as above for masonry buildings;

(ii) a plan of the building as required by sub-rule of the rule as above.

The plan must show—

(*a*) the width of the foundation for pillars, or beams for the support of the roof;

(*b*) the size and shape of main posts and beams;

(*c*) the height of the lowest floor of the building above the highest level of the site and the crown of the nearest road;

(*d*) the level of all courtyards and open spaces in the building or premises, and the plinth level of buildings with reference to the level at the centre of the nearest street;

(*e*) The size of windows, doors and ventilation openings for room on every storey.

(iii) The specification accompanying such an application must contain all the particulars required by the sub-rule of the above rule for masonry buildings.

C—To encourage the building of houses on standard plans the following bye-law is inserted:—

The plans of the building required in the bye-law as above described need not be submitted if the applicant sends with the site plan an intimation of his intention to construct the building in accordance with the standard plans of the Public Works department for Indian houses. A copy of any of these plans can be supplied to the applicant by the Municipal Engineer on payment of a nominal fee of 2 annas.

The author sincerely hopes that this paper has succeeded in pointing out the importance of good building bye-laws and that their enforcement is a necessity if the efforts to improve the national health by sanitary measures are to be followed by marked success.

S. A. HARRISS, M.B., C.M., D.P.H., D.T.M. AND H. (CAMB).,

MAJOR, I.M.S.,

Sanitary Commissioner, United Provinces.

The All India Sanitary Conference,

MADRAS, NOVEMBER 1912.

Town Improvements and Drainage in India

BY

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Town Improvements in India.

Definition.

The word **Town** is defined as "any collection of houses, larger than a village," and the word **City** is defined as "a large town with a Corporation" and the word **Corporation** is defined as "a Society authorised by law to act as one body."

Applying these definitions to the villages, towns and cities in India, and examining what evolutions have taken place, during the past one hundred and fifty years, we do not find villages under British rule rising to the status of towns, nor do we find that more than half a dozen towns have developed into cities. We shall apply a better test than that of an ordinary Dictionary definition—the test by population. Out of a total population of three hundred millions in India only ten per cent. live in towns with a population 5,000 and over, whereas in England 77 per cent. of the total population live in towns. This shows the difference between a purely agricultural country and a manufacturing country, and further shows that India can never become a manufacturing country; it has not exhibited much tendency in that direction, during the past one hundred years of peace and good government.

Therefore we can appropriately describe India as a country of Villages. It is destined to remain in that condition for long years to come, judging from the great lack of organization and of combination among the people of India generally.

Origin of Towns in Ancient India.

In an extensive agricultural conntry like India, where nearly two-thirds of the population are and have been engaged directly in agricultural and pastoral occupations and where the actual needs of the people were few and were generally found within the limits of each village, the formation of towns and cities was both unnecessary and impossible. The difficulties and dangers of communication and of transit of even agricultural products from an area of plenty to an area of scarcity were almost insuperable in the past and consequently

in ancient India there was very little of internal trade and much less of sea-borne trade.

But when we look into the political history of India in the centuries that have gone by, we shall understand how towns were built and how they flourished in the India of the past.

If we look into ancient periods of Indian history, we find such names as Hastinapura, Indraprastha (Delhi), Dwaraka in Gujrat, Ayodhya (Oudh), Ujjain (Malwa), Kapilavasthu (Nepal), Vaisali (Patna), etc., mentioned, as the capital cities of various kingdoms, founded long prior to the commencement of the Christian era.

The building of towns in ancient India by powerful rulers was more for military purposes than for the advancement of commerce or the development of industries. Every chief built his own fortress, and in course of time a number of houses clustered round the fortress and the palace and gradually acquired the proportions of a small town.

There are other towns in India which owed their origin to Religion. Religion in India grew with the old kingdoms. The people have all along maintained an intense devotion to their religion, in spite of the great political changes that have passed over the country. Their places of worship were the temples, and pilgrims to these temples collected in very large numbers sometimes from all parts of India. The permanent residents of the town were directly or indirectly dependant on the temple for their living. Religion and charity dictated the construction of large chattrams and dharmasalas for the temporary residence of devotees attending the festivals of the temple.

The sites chosen for these temple towns were in many cases not suitable for military purposes and hence there have not been many changes in the sites of these towns.

But there are instances where the seat of government was also the place of an important shrine, as for example, Conjeevaram, Madura and Tanjore in Southern India and Benares in Northern India. The towns have at a very early stage in their history developed into large cities with a teeming population. These are, no doubt, in some cases broad streets and stately houses, but the Sanitary Engineer of to-day is confronted with the question of providing means of light and ventilation and drainage for very extensive and congested areas in cities of this description. The streets were formed and the houses were built without much regard to sanitation, and the increase of population during a long period of peace has renderd the problem more difficult of solution.

Destruction of the Old Towns in India.

From the 11th century to the beginning of the 18th century, the Mahommedan Rulers of India destroyed several old fortresses and towns and built new fortresses and new towns.

During this period many old towns were deserted and fell into ruins. Insecurity of life and property were unfavourable to the gradual and natural growth of towns; continual terror in the minds of the people favoured over crowding and we notice to-day in almost all the towns of ancient India congested areas, ill lit, ill ventilated, and imperfectly drained.

Growth of Towns in New India.

A thousand years of ravages committed by foreigners on India have neither changed the sites nor affected the importance of its old towns. Two thousand years of civilization in the past have not favoured the growth of towns and cities. Two hundred years of peace and prosperity under British rule have tended to the development of commerce and the building up of large cities and towns.

In the 19th century we witness the construction of palatial houses for private residence. People had the desire, the money and the knowledge, to build good and substantial houses, but unfortunately had no correct ideas of building them on sanitary principles and in sanitary localities.

The old prejudices of the people in favour of building on plots of ground, inherited by them from their ancestors, are responsible for more than 90 per cent. of the costly houses which are now in existence or are daily being built in towns.

Remedial Measures to Prevent Overcrowding.

The possibility of expansion of a town or city must be one of the main principles which should determine proposals for the improvement of existing towns or the building of new ones. All Public Offices, Hospitals, Markets, Shop lines, etc., should be erected in new sites and arranged conveniently, so as to allow the growth of a new Town around it. The opening of tram lines and the introduction of a local train service would greatly help town extensions. A practical suggestion on the lines above indicated in the case of Madras, would be to extend the tram service to the western limits of the city. It may not be very profitable from the investors' standpoint but the certainty of a more equal distribution of population would be assured. Teynampet, Nungumbakam, Chetput, Egmore, Kilpauk and Perambur, the western villages of the City of Madras, are all healthy localities and if cheap means of communication with the busy centres be brought about, the congested areas of Triplicane, Chintadripet, Choolai and Georgetown will be considerably relieved. Further if a number of Public Offices such as the proposed offices for the Madras and Southern Mahratta Railway and the South Indian Railway are located in the now disused Spur Tank there will be a decided improvement in the Third Capital City of India.

The Principles of Widening Roads.

All sanitary improvements should begin with the most congested areas of a city. The widening of roads is of primary importance ; architectural appearance should be only secondary. The opening up of broad roads in congested areas improves the dwelling locality of the poor while the widening of roads in business areas would only facilitate traffic. More attention should be paid to dwelling areas. Localities inhabited by the backward classes such as the weavers, the cow herds and the mill hands, as also Paracheries, must be attended to first. In widening roads partial aquisition of houses should as far as possible be avoided, for the reason that when people get a good price for say about 10 feet of frontage, they manage to rebuild the house, on the area left over without any appreciable diminution in the number of persons who occupied the original larger area.

Acquiring Blocks.

What applies to a large progressive city would not apply to the generality of small towns. In the latter case as well as in the former, however, open areas of respectable dimensions in the midst of a block of houses will be greatly beneficial. It would be an advantage to acquire a number of houses and create open areas in the midst of congested quarters. This is suggested from financial considerations. We know that the slow progress made in this direction is due to considerations of cost. Dead-ends of lanes must be minimized, for such lanes are generally kept in a filthy condition.

Building Rules and Regulations.

There are several Moffusil Muncipalities, small towns and villages which have been and are practically beyond the operation of sanitary regulations. The help and guidance of the Sanitary Engineering Department must be extended to the smallest village. Sanitary Assistant Engineers or Inspectors should be employed whose duty it shall be to inspect, and report to the Chief Sanitary Engineer on the water supply, drainage, public latrines, and the general sanitary conditions of the villages in the area under his superintendence. The Chief Sanitary Engineers would then be in a position to advise the Local Fund Engineers as to the steps that should be taken. People in villages understand and obey more readily than people in towns, all laws and regulations pertaining to health.

The Siding System ot Road Improvement.

Suppose a road is 1,000 ft. long and 12 ft. broad with buildings on either side of single and double floors mixed. One practical way of improving the road, though it may be unsightly, would be to buy up houses, say to a length of 200 ft. and to the full depth of the house, and to leave it open permanently for traffic. There are several towns in which we have a number of winding roads. In Secunderabad and Hyderabad we meet with a large number of roads of this description. Several well built and costly houses lie away from main roads, and the houses are reached by long narrow lanes in many cases not more than 6 or 7 feet in width. It is a regular labyrinth of roads and lanes.

Public Bathing Places.

Two or three houses in a congested area may be purchased and a healthy bathing place constructed to meet the demands of small areas of population. There are a few such public bathing places in Madras while there ought to be a large number not only to meet the demands of the permanant population of the locality but also for the convenience of a large number of visitors who make a temporary sojourn in the city. These bathing places can be located at the top of a sewer line and the waste water may with considerable advantage be utilsed to flush the drains, and automatic flush tunnels of small capacity may be constructed. If necessary the bathing platform may be raised, to secure about 2 feet of head for the flush tank to work. These public places will be a great boon to the poor and will further be an inducement for them to develop cleanly habits. There is one more advantage in multiplying these public bathing houses. The water consumption in the houses of the poor will be considerably reduced. This will in its turn

put in less rubbish and less silt in the house connections in towns which have an underground system of drainage.

Housing the Poor and Building Schools for Children.

The public health of a town or city is largely dependant on the sanitary condition of the houses of the poor and their surroundings. At present in large towns and cities the portions occupied by the poorer classes are generally in a highly insanitary condition. The outbreak of epidemics in such areas under climatic conditions favourable for their growth could not be combated with any degree of success.

The general health of the less congested and more sanitary portions of the city naturally gets affected by contagion from the less healthy areas. In the interests of the poorer as well as of the richer classes, therefore, the sanitation of areas inhabited by the former is of vital importance. Municipalities and Corporations should provide housing for the poor at public cost in as many centres as may be necessary, and the necessity for extending the same provision, for the School children in all the villages, should attract the attention of officers who are made responsible for the public health of this vast continent of peoples. Further the sanitary condition of, in fact, every house in villages, towns and cities should be brought under the supervision and control of the administrative officers. The question of healthy houses for children is of paramount importance, and the space allowed in this paper is quite insufficient either to fully expound the subject, or to make proposals as to how this can be effected.

The poor working classes in Madras do not and cannot afford to pay for lodgings more than a rupee and a half or a rupee for a family consisting of four or five members. What dark, damp, dirty, and insanitary holes such lodgings are, can be better imagined than described.

Insanitary Areas.

The existence of insanitary areas, marshy areas, stagnant pools, half-dried up tanks, unsightly cottages built of mud walls, and allied matters come within the sphere of the activitives of a Town Improvement Trust. The only method which appears to be feasible is that of gradual improvement, and a proper allotment should be made for such improvement each year.

That the work of improvement must be done is an undisputed fact, and every town must organise its own Improvement Trust, its aim being to improve the sanitation of the local area.

Prevention of Overcrowding in Houses.

In every proposal for improving a town the Engineering difficulty is only a very small fraction of the work. The main work lies in dealing with a class of people who are poor, ignorant, and obstinately addicted to their old habits of life. Well-meant suggestions for their own welfare are viewed with contempt or suspicion. To fix the minimum living area for each tenant and to insist on a strict compliance with the rule would gradually result in a more even distribution of population and the general improvement in the health of the poor. For any violation of this rule, the landlord who leases the houses should be held responsible.

Preventive Methods for Reducing Town Population.

If the superfluous population that always congregate in numbers, be provided with accommodation outside the town, there will surely be better sanitation in the town. This is not a simple problem and requires much thought and also the co-operation and help of the rich citizens of the town in whose interest this is done. The beggar classes, the idlers, the lepers, day labourers who come into town only when the harvest fails, the mill hands and such other people will be very glad to live outside the town provided proper arrangements are made for them outside the city. A home for the aged and infirm, an asylum for lepers, cheap and sanitary lodgings for the labourers and petty artisans and mill hands and cheap conveyance to the city would ensure better sanitary conditions in the city.

The Improvement Trust in India is a new organization, and its functions are peculiarly difficult. Different departments have to work in co-operation. Further no two cities present the same kind of problems for solution ; every city has got its own peculiarity, and proposals made for one city, would not be quite applicable for another. But questions such as " the Preservation of Public Health," "The supply of pure air," "Reduction in the number and area of insanitary localities," "Attention to the living rooms of childern," "the Housing of the poor," "Sanitary Inspection of houses," " Declaring of houses unfit for human occupation," in fact every improvement which will tend to remove disease and improve the general health of the locality are present in all towns and cities. In a subject of such great magnitude, importance and difficulty a paper like this may throw out a few suggestions only, but cannot exhaustively deal with any of them.

II.—Drainage Schemes for Indian Towns.

Bombay presents an object lesson in Drainage Engineering for all other cities in India as well as for cities in other parts of the world, similarly conditioned. Its Drainage history is therefore worth a careful study.

1845-56. The first serious attempt to improve the sanitary condition of Bombay was made during this period. A main drain from Crawford Market to Falkland Road was built and covered. The size at the commencement was 2 feet by 2 feet and at the end 20 feet 3 inches by 8 feet 6 inches. This drain carried all the storm water in the monsoon period and also such sewage as was discharged into it. This was done on the combined system.

1856-1878. The sanitary condition in Bombay became very serious. Many schemes were considered and the real construction work was commenced only at the last mentioned date, on the separate system.

In several instances, this underground storm drain, even to this day acts as a safety valve for the sewage from houses, when the street traps get choked up. The arrangements here are unsatisfactory.

1878-1893. A large area of Bombay had been drained, and yet several populated areas remained undrained.

Madras also can present some subjects for study.

1884-1890. The first serious attempt to improve the sanitary condition of Madras was made at this period. The George Town surface drain was commenced and completed.

1890-1902. This was the period of discussion and consultation of experts During these years nothing was actually decided upon.

1902-1905. The underground system of drainage for two or three districts was carried out. The gradient allowed for the sewers was the principal defect in the scheme. This was a great blunder and consequently the scheme proved a complete failure.

1912. The Tondiarpet drainage in Madras was more carefully designed and is now under construction. There is a very fair chance of success, for the subject has received much thought and study in the right direction.
Conclusions from the above :—

We see that the drainage question of Bombay was seriously taken up in 1878, but the drainage question of Madras was seriously taken up only in 1912.

This shows apart from other things that need for sanitary improvement is not quite so urgent in Madras, as it is in Bombay and that in this Madras has an advantage over Bombay.

It also shows that in Madras a long time has been allowed to expire between the elaboration of the design and the commencement of actual work; that the progress in execution has been tardy several populated areas being left undrained for years,—and that considerable time was also taken up in watching the success or failure of such experimental projects.

When we consider that in Madras only one section was taken up at a time and that the surface drainage in the city has been working in such a flat District, for a number of years, and that this was a real improvement on the previous condition of affairs in that locality, with its sewage ditch drains stagnating in thickly populated areas, and when we also take note of the fact that many problems relating to an underground system of drainage have yet to be satisfactorily solved, one is tempted to ask the question whether smaller towns and less densely populated areas, cannot get on for some years just as George Town, Madras has done, with a complete system of properly designed surface and underground drainage combined. The surface drains on proper and improved principles can be constructed wherever good gradients are available and allowed to do their work, till the other necessary town improvements are made and also till the people learn to better understand the laws of health.

Surface Drainage *versus* Underground.

A quarter of a century ago there was not so much opposition to carrying sewage in open drains as we find at the present day. On the other hand it was believed at that time that the open drain system was the only system suitable for the conditions obtaining in many Indian towns, and for the wants of the people, and one from which the majority will derive the greatest benefit.

Engineers who have paid much attention to the Drainage of Indian towns, are more or less agreed on the following points at the present day :—

I. They have no doubt that, if designed on correct principles, the underground separate drainage system is the only proper method by which sewage water should be collected and conveyed to its destination.

II. They have no doubt as to what these correct principles should be in carrying out drainage works in India.

III. They have no doubt that these correct principles cannot be advantageously applied to the followiug cases :—

(a) *The Water-carriage System* :—Underground drains and water-closets, though the best system, can be introduced only gradually in Indian towns, as for a long time to come the number of houses to which this system can advantageously be applied will be few in number.

(b) *The underground Pipe House—Drainage* is not suitable at present for the majority of houses in Madras, and further would be quite impracticable in many cases.

(c) *Street Side Drains* :—For a long time to come, some kind of side drains will be a necessity in localities consisting of irregularly and poorly built houses ; of course the conditions will gradually improve and till the gradual disappearance of such localities, surface drainage is suitable.

The inferences from the above are as follow :—

(1) In the same towns along with a system of surface drains for certain areas, a complete and satisfactory system of underground drainage may be introduced in suitable localities.

(2) The house drainage question on approved principles must be put off for the present in the case of many Indian towns.

(3) Except in the case of towns built on flat areas, surface drainage, designed on correct principles will be a great sanitary improvement till such time the towns grow in importance and people learn to keep the sanitation of their own houses in a satisfactory condition. Till such time the introduction of underground drainage is unsuitable and is bound to be a failure when conditions have changed, the underground drainage system can be easily introduced. Surface drains may then be used for the purpose of carrying away storm water only.

Underground Drainage.

A few of the principles to be adopted may be mentioned here :—

Size of Sewers.—This is usually fixed to carry off in six hours one half of the quantity of sewage from the section.Each section must be separately taken up and studied and the population as per last census should be noted. This section should be studied with reference to a possible increase or decrease of population in the future with a standard of minimum living area for each inhabitant. Allow-

ance should be made for reduction in the number of occupants in overcrowded areas and for increase in the number of occupants in thinly populated areas. The result of this calculation substracted from or added to the population of a section will give the anticipated future population of that section. Such localities must then be declared suitable or unsuitable for future extensions and people should be induced to occupy or vacate the areas so marked out.

The second point which requires attention in fixing the size of sewers is to find out what quantity of sewage water gets into a sewer per head of the population per day.

This is generally done on the assumption that, all the water allowed per day per head of the populations, by the water-supply scheme gets into the sewers.

We shall examine what portion of this 20 or 25 gallons per head allowed goes for actual domestic consumption, for only this quantity and no more finds admission into the sewers. The quantity provided for non-domestic purposes such as watering plants in garden houses, for public gardens, for roads, for avenues and water allowed for buildings under construction and such like uses never enters a sewer. It would appear that 7 to 10 gallons per head is quite ample for all domestic purposes in a large Hindu family. Omission to consider this will involve a greater error in the result than omission to take account of the future increase or decrease of population. The suggestion made here is worthy of serious consideration.

2. *Gradients in Sewers.*—The minimum gradients which will give self-cleansing velocities in sewers, is a very important item and the following gradients are either proposed or adopted by different Engineers for different Towns :—

Size of pipes.	1 Madura in 1906.	2 Madras in 1912	3 Poona in 1912.	4 Madras in 1902.	5 Bombay.
4"	1 in 52	1 in 40	...	...	...
6"	1 in 100	1 in 135	...	1 in 330	1 in 160
9"	1 in 190	1 in 230	1 in 120	1 in 500	1 in 265
12"	1 in 295	1 in 340	1 in 265	1 in 600	1 in 385
15"	1 in 415	1 in 460	1 in 520	1 in 1,000	...
18"	1 in 545	1 in 580	1 in 660	1 in 1,000	...
21"	...	1 in 720	1 in 660	...	1 in 660
24"	...	1 in 860	...	...	...
30"	...	...	1 in 1,190	...	...

The bad gradients given in col. 4, in Madras have been the cause of the complete failure of the scheme carried out in 1902—1905.

3. Separation of storm water from the sewage. There is unanimous agreement as to the correct principle, but Engineers adopt different designs in arranging this, probably on account of differences of opinion amongst them in the sub-principles of the main question.

4. Separation of silt before the sewage enters the road side syphon; here also the principle remains undisputed, but there are differences of opinions in the sub-principles.

The Back-Bone of Drainage Schemes in Indian Towns.

The principles set out in paragraphs 3 and 4 above form the back-bone of the drainage schemes for Indian towns and the suceess or failure of the innumerable contrivances devised from time to time by various Engineers very largely depends on the extent to which the principles have received attention or study. There was considerable want of due attention to these matters at the beginning and the lessons from the failures are before us and in recent schemes advantage has been taken of the experience gained by these failures.

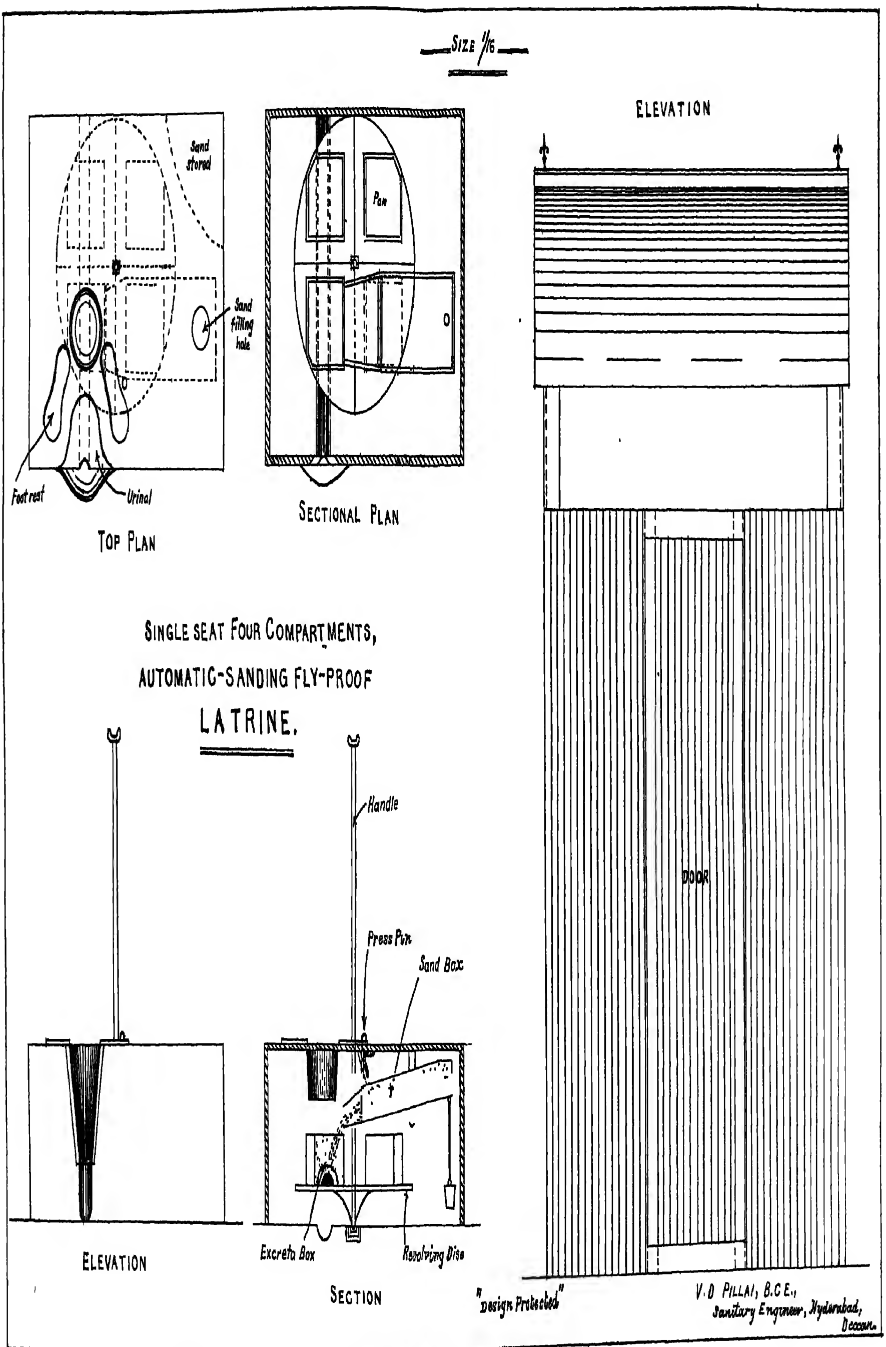
In Ahmedabad and Poona a strong iron grating is provided inside the house to prevent all floating substances such as straw, paper, rags, etc., except sand and silt which do not float, from getting into the sewers, and I understand this works satisfactorily. In Madras, (1) the existing house connections are provided with an iron grating, but they are very indifferently fixed about 1½ inch through which much of the floating substances pass on to the street syphon. But in Madras (2) the proposed house connections do away with the old iron grating and substitute a removable silt catcher just before the sewage finds entry into the street syphon. This is an original idea no doubt, but the objection to this is stated below.

What properly is the duty of the occupiers of the house is transferred to the Corporation staff. The Corporation undertakes to remove all sewage by the street sewer and to see that no insoluble or objectional substance thrown out of a house, finds admission into the syphon. Public rubbish bins are provided in all streets. The people who choose to live in cities and towns must be made to understand that the sweepings of houses should be thrown into the receptacles and not sent down the drains; no law can be called severe which insists on people observing rules of sanitation necessary for the maintenance of healthy surroundings. In spite of dfficulties and opposition the people must be taught to do their duty properly. I prefer the transfer of the silt clearing and rubbish removing operations to the occupier of the house by giving a 2″ drop in the house drain in front of the grating and fixing a closer grating with ¼″ wires.

The drainage question in India is beset with several difficulties. The great number of these come from the people who either do not deserve ideal conditions so early or who are not sufficiently educated to use appliances which have been found useful elsewhere or to understand the danger of breathing impure air.

Taking all the facts into consideration, one has to recommend surface drains,very reluctantly, as the only suitable system, in less important localities, and their immediate execution. The underground system may be introduced gradually but there must exist surface drains in all towns as a temporary measure for some time to come.

Thompson & Co., Printers, Madras.


SIZE 1/16
ELEVATION
Sand stored
Sand filling hole
Foot rest
Urinal
TOP PLAN
Pan
SECTIONAL PLAN
DOOR
SINGLE SEAT FOUR COMPARTMENTS,
AUTOMATIC-SANDING FLY-PROOF
LATRINE.
Handle
Press Pin
Sand Box
Excreta Box
Revolving Disc
ELEVATION
SECTION
"Design Protected"
V. D PILLAI, B.C.E.,
Sanitary Engineer, Hyderabad,
Deccan.

Relief of Congestion in the C. & M. Station, Bangalore and Results:

THE advent of Plague in this Station in the year 1898 (September) and its subsequent and periodical recrudescence every year gave the first impetus to sanitary reform.

A couple of years after the disease had established itself here, only minor work in the direction of drainage and improved conservancy were instituted. But the real compaign against the insanitary and congested parts of the town was started in the year 1906 by the vigorous efforts of Mr. P. L. Moore, I.C.S., C.I.E., (the then President of the Municipality and now President of the Madras Corporation) who was supported by the Hon'ble Mr. S. M. Fraser, I.C.S., C.S.I., British Resident in Mysore at the time.

The locality selected for demolition and improvement was the central and most thickly populated part of this Station, namely, a portion of the Indian Bazaar familiarly known as South Blackpully. The area of this is 51·53 acres. Before demolition the number of houses here was 1,952 occupied by about 2,700 families consisting of a little over 12,000 persons which included a large number of Mahomedans. This was approximately a seventh of the population of the C. & M. Station at that time. (The census population in 1901 was 89,599, and in 1911 it rose to 1,00,834. In 1891, *i. e.*, 7 years before the appearance of plague, it was 93,540). The incidence of plague and other epidemics was highest in this locality. The density of the population in South Blackpully before demolition was about 240 per acre. It is now about 130 (per acre).

[Ever since the introduction of tap water in 1897 there has been no cholera epidemic].

Demolition under the Land Acquisition Act began in 1906, the area then covered being 24·16 acres. In selecting houses for demolition, main thoroughfares, were avoided, and new roads were opened through the heart of the filthiest and most insanitary slums in such a way as to facilitate the circulation of air and the alignment of drains. The number of houses acquired and dismantled was 294 and the number of families removed was 436. In January 1907, another lot of 300 houses were similarly dealt with, thus bringing the final total to 594 houses (demolished) which works up to about 32 per cent. of the original number of houses. The amount spent for compensation and improvements was Rs. 1,15,697. Further, the houses which were left untouched or partially demolished in the above acquisition were gradually improved by the owners themselves at an estimated cost of a little over a lakh of rupees.

After demolition and renovation and a proper alignment of roads and improved drains three large and several small tracts of open land were demarcated

11[illegible]

and now serve as excellent lungs for this once highly congested area. One of these large squares—Stephens' Square, has been utilised, on account of its proximity to the General Market for the construction of about 60 non-residential shops on its South, East and West sides, which realise a gross annual rental of about 2,000 rupees—a sum which in part compensates for the outlay on demolition. No permission is given to anyone to build upon these open spaces, and they will be maintained strictly as such. The whole scheme was designed and carried through by our former Municipal Engineer Mr J. H. Stephens. The statistical tables, *vide* Appendices A, B, C., compiled by the Health Department show the great improvement in the death rate of South Blackpully and also of the Station as a whole, together with a slight falling off in infantile Mortality as the result of the recent sanitary reforms.

Again, houses of groups of tenements which are habitually tenanted by several families are marked down and entered in a special Register, and the maximum number of inmates (families) each should contain is prescribed by the Health Officer. All these houses are visited regularly by the Health Department and in all cases where the maximum is found to be exceeded the provisions of the Bangalore Municipal Law, S. 137, (*Vide* Appendix D) are enforced. At the same time necessary steps are taken to remedy all sanitary defects, with regard to house-drainage, ventilation and latrines.

To provide accommodation for the unhoused people in Blackpully and to encourage migration from congested areas, a fine tract of arable land, measuring 50·35 acres, situated to the north of the Station was acquired at a cost of Rs. 13,908 and laid out into 470 plots, 66 feet by 33 feet each. All facilities were given to capitalists and others to build model houses on these, conforming to certain building regulations as detailed in Appendix E.

"Fraser Town" was planned out, and the whole scheme was pushed through by Mr. J. H. Stephens (our former Municipal Engineer) with the co-operation of the leading Hindu and Mahomedan gentlemen of the Station. An Elementary school, Public dispensary, Public markets were the gifts to this new town, by Mr. B. P. Annasawmy Mudr., C. I. E, also a Mosque by Khan Bahadur Hajee Ismail Sait, two of the leading citizens of Bangalore; the M. S. M Railway putting up a Flag Station. At last year's Sanitary Conference in Bombay, you Sir, referred to Fraser Town as "a plague free spot in a plague infected town." In April, this year, when you visited the place, you were convinced of the rat-proof characters of these houses. Even this year, up to this time, we have had no cases of indigenous plague in this locality. Fraser Town has the inevitable disadvantage of being situated in the circumference of Bangalore, and at a distance of about 1½ miles from the General Market. It is therefore no easy task to counteract the strong reluctance of the languid Bangalore cooly and artisan to migrate from their old haunts to a distant sanitarium. An attempt is therefore being made to provide a counteracting focus of trade and occupation immediately north of Fraser Town. Some 47 acres of arable land have been acquired at a cost of Rs. 13,075. This area has been mapped out into 112 plots, each measuring a quarter of an acre (120 ft. by 90 ft.). The plots are being sold at prices ranging from Rs. 300 to 600 each, according to their situation. The realisations from the sale of plots, it is hoped, will cover the cost of acquisition, of laying out roads and drains, water and light and a central park. We shall thus have our new town without any burden to Municipal finance.

This new town will form an ideal settlement for Europeans and members of the Domiciled Community, as well as for well-to-do Indians, and it is expected that their requirements will bring trade and population to Fraser Town and stimulate business there.

To guard against land-jobbing, it is made a condition of sale that the building in each plot must be finished within eighteen months of the sale of allotment of the site. (*Vide* Appendix F). It is expected that the new town will bring in a revenue to the Municipality of Rs. 3,000.

To supplement the scheme, every encouragement has been given to the Peninsular Tobacco Company of Monghyr to establish a factory in the Station. The Company has purchased some 24 acres of arable land in a site to the east of the new town, and their buildings are nearing completion. It is expected they will employ a staff of about a thousand hands and that their employees will settle in the vicinity. To accommodate them the Municipality is acquiring more land in the neighbourhood of the factory, and arrangements are being made for settlements of Panchamas, caste Hindus and Mahomedans. On the land thus acquired, the Municipality will erect a few model buildings, and it is hoped that private enterprise will provide for the rest.

A further inducement has been made by the grant on favourable terms of 7 acres of land in the fore shore of Ulsoor tank to garden cultivators, who, it is expected, will supply the local demand for vegetables. This grant of land will cost the Municipality nothing and will bring in an annual revenue of about Rs. 300. This little scheme at first sight, may seem trivial but, it is felt that no effort should be spared which may serve to render these new settlements attractive and to counteract the forces that draw population to the heart of Blackpully.

Another step in the same direction is the Tramway Scheme now under the consideration of the Government of India. From the point of view of the C. and M. Station, this Tramway Scheme is purely a sanitary measure, for it is recognised that suburbs cannot flourish unless easy communication can be afforded with the heart of the town. Not only should the Tramway enhance the rateable value of the new town and Fraser Town, it should also bring traffic to Bangalore East Railway Station and with traffic comes trade.

A scheme is on foot also to lay a third rail from Bangalore City Railway Station to Bangalore East Station to enable metre-gauge traffic to run to Fraser Town without transhipment. This scheme however is costly and the time is not yet ripe to press it. The fact that the junction of the gauges is at the City Railway Station is a serious handicap to the trade of the C. & M Station, and indirectly it increases the tendency for business to concentrate in the heart of Blackpully.

The following is a brief programme of the works outlined by Mr. F. J. Richards, M.A., I.C.S., (our present President) which are to be undertaken very shortly with the recent generous grant of Rs. 50,000 from the Government of India :—

(1) Acquisition of a group of nearly 60 houses in one of the highly congested and plague-stricken areas, occupied mostly by caste Hindus. Demolition work has begun, and by a re-alignment of roads and lanes and improvements to unevicted houses, ample air space will be provided for these blocks of back to back houses. The cost under this head will be about Rs. 20,000.

(2) The opening up of Chuppercheri, one of the worst slums in the Station, at a cost of about Rs 2,000.

(3) Demolition and opening up of a collection of a group of 110 very old and uninhabitable mud huts, now occupied by pensioned men of the Army Bearer Corps with their families. These were recently transferred to the Civil Municipal jurisdiction by the Military authorities.

(4) Construction of model single-family tenements be the Municipality to suit the working classes amongst caste Hindus.

The chief obstacles encountered are :—

(1) Payment of heavy compensation which the Municipality is unable to bear without Government assistance.

(2) Lack of funds for building model houses at Municipal cost for families unhoused.

(3) Prejudices of landlords and tenants; the former do not fully realise the importance and advantages of putting up model houses, while the latter cannot be easily persuaded to shift to new locations.

(4) Migration of the people ejected from tenemented houses from one locality to another.

Other sanitary improvements which have been carried out from time to time and have directly or indirectly relieved congestion are the following :—

(1) Complete demolition of the old Slaughter Houses which were formerly in the heart of the town, and the construction of the present Slaughter Houses at the north-western corner of the Station which have evoked praise from visitors. The old Mutton Slaughter Houses have been converted into an Elementary school for Mahomedans.

(2) The wholesale removal of all the Tannery Depots and godowns to locations outside Municipal limits on account of their close proximity to Fraser Town and the new Extension. The majority of these dilapidated buildings near the existing Slaughter Houses have been acquired for the purpose of putting up a Sheep Market.

(3) The two night soil trenching depots near Fraser Town have also been discontinued at the instance of Mr. F. J. Richards by the reintroduction of the contract system for disposal of refuse. These lands have been leased out to ryots for cultivation purposes and may eventually be utilised for further extensions.

(4) Though the principal extensions of the Station have been towards the northern direction, several new cottages have been built or are in course of construction at the south end, *viz.*, Langford Town. These are mostly inhabited by members of the domiciled community on account of its nearness to Richmond Town (a popular Anglo-Indian residential locality) and the several European Educational Institutions.

(5) The conversion of two untidy squares next to the General Market, with rows of badly built shops (known as the old Evening Bazaar) into one large square with three rows of neat model shops, yields a good income to the Municipality.

(6) A scheme has also been drawn up for sustaining the reputation of Bangalore as a garden city, by systematically restoring the avenues, which of late years have fallen to decay, and laying out and maintaining a number of Parks, Gardens and Recreation grounds,—a scheme, which, if carried through, will bring Hockey and Football within the reach of the children of even the most closely inhabited areas.

(7) In addition, the sanitary improvement of other areas where demolition is not necessary is to be systematised, especially the Paracheries (Panchama Settlements) which are in Bangalore exceptionally numerous. A scheme is being drawn up for the improvement of r oads, drainage, lighting and water-supply in each Paracheri and an annual allotment will be made to carry through the programme.

The present financial condition of the Station Municipality is very promising, but without Government grants, it is not possible to spread town improvements over further areas which still require attention. In spite of the excellent work done by the local plague department, if Bangalore is to be once more a plague free town, it can only be attained by a systematic and periodical campaign against insanitary areas.

The demolition effected in Blackpully and the laying out of Fraser Town formed part of a general scheme for the relief of congestion drawn up in detail by Mr. J. H. Stephens in 1905, the total cost of which was estimated at 18 lakhs. This scheme will require revision in the light of more recent experience and in view of the requirements of the Military authorities.

In order to ensure continuity of policy a scheme is under preparation for distributing the whole area of the C. & M. Station into Military and Civil spheres, and in the case of the latter for laying out the unbuilt area for future requirements. Some such scheme seems necessary in order to anticipate haphazard expansion and such a scheme may not of course be materialised for a good long time yet and may be subject to all manner of modification, but it seems imperative that something of the kind should be formulated if the Municipality is to control effectively the roads, drainage and general sanitation of its future suburbs.

The congestion of our slums, the longstanding encroachments on some of our main arteries of traffic, the close agglomeration of cottages known as Richmond Town and many other characteristic features of Bangalore afford object lessons of the consequences of past neglect. It is hoped at a very early date to crystallise our Municipal policy into a more effective building bye-law and that before long our hands may be strengthened by the enactment of Town Planning Act on lines similar to those adopted in England, as fore-shadowed by the Hon'ble Mr. L. C. Porter, I. C. S., at the last Sanitary Conference.

(Sd.) S. AMRITARAJ,

L. R. C. P., & S. (*Edin*),

D. P. H. (*Cantab*).,

Health Officer,

C. & M. Station, Bangalore.

APPENDICES.

APPENDIX A.

The following statistics from the Health Department show the great improvement in the death rates of South Blackpully after demolition and improvement.—

YEARS.	Death Rate per mille.
1898—99	127·76
1899—00	28·97
1900—01	58·06
1901—02	54·58
1902—03	85·17
1903—04	70·00
1904—05	63·28
1905—06	78·25
1906—07	55·48
1907—08	61·40
1908—09	49·04
1910—11	56·74
1911—12	40·09

It must be mentioned that the above death rates include the deaths at the Lady Curzon Hospital.

APPENDIX B.

Comparison of Total Mortality and Plague with their ratios from 1898 to 1912.

YEARS.	Population.	DEATHS.		RATIO PER 1000.		Ratio excluding Plague.	REMARKS.
		Total.	Plague.	Total.	Plague.		
1898—99	1,00,081	7,721	*3,321	77·15	33·18	43·97	
1899—00	Do	2,587	348	25·85	3·48	22·37	Epidemic was not severe.
1900—01	Do	5,634	2,574	56·30	25·71	30·59	
1901—02	89,599	4,537	1,535	45·33	15·34	29·99	
1902—03	Do	6,760	3,527	74·33	39·36	34·97	
1903—04	Do	5,098	2,591	56·89	28·92	27·97	
1904—05	Do	4,637	2,134	51·75	23·81	27 94	
1905—06	Do	4,836	1,748	53·97	19·50	34·47	
1906—07	Do	3,759	868	41·95	9·68	32·27	
1907—08	Do	4,134	1,368	46·14	15·27	30·87	
1908—09	Do	3,358	565	37·45	6·31	31·14	
1909—10	Do	3,674	555	41·00	6·20	34·80	
1910—11	Do	3,937	806	43·94	8·99	34·95	
1911—12	1,00,834	3,531	925	35·01	9·18	25·83	

*The first appearance of Plague was in September 1898.

APPENDIX C.

INFANTILE MORTALITY.

This table below gives the Infantile Mortality figures from 1900.

Year.	Ratio of infantile deaths per 1,000 births during the year.	Census population of infants under one year of age for 1901 and 1911.
1900—01	338·86	2,703
1901—02	368·12	,,
1902—03	338·78	,,
1903—04	337·40	,,
1904—05	326·60	,,
1905—06	418·67	,,
1906—07	345·42	,,
1907—08	302·33	,,
1908—09	340·12	,,
1909—10	353·48	,,
1910—11	320·30	,,
1911—12	267·83	3,353

APPENDIX D.

Bye Law No. 7. Lodging houses and buildings occupied by more than one family.

B. M. L. SECTION 137 (1) (*d*).

1. Whenever it is certified by the Medical Officer or the Health Officer that any building or part of a building which is let in lodgings or occupied by members of more than one family, is so over-crowded as to endanger the health of the inmates thereof, the President, after such enquiry as he thinks fit to make, may by written order, require the owner of the building, within a reasonable time, not exceeding six weeks, to be prescribed in the said order, to abate the over-crowding thereof by reducing the number of lodgers, tenants or other inmates of the said building.

In this Bye-Law "building or part of a building which is let in lodgings or occupied by members of more than one family" shall include every building or block of buildings, within a common enclosure occupied by members of more than one family.

If the owner of the said building shall have sublet the same, the landlord of the lodgers, tenants or other actual inmates of the same shall, for the purposes of this Bye-law, be deemed to be the owner of the building.

It shall be incumbent on every tenant, lodger or other inmate of the building to vacate on being required by the owner so to do in pursuance of any such requisition.

2. Every house which is ordinarily used as a lodging house shall be registered in the Office of the Commission, and a license for the same obtained by the keeper or manager thereof.

3. If it is certified by the Medical Officer or the Health Officer that the house is by reason of over-crowding, uncleanliness, or the want of proper ventilation unfit for a lodging house, the President shall refuse to grant such license until the cause or causes of such unfitness have been removed.

4. Every licensed lodging house and every building or part of a building which is let in lodgings or occupied by members of more than one family shall be open to inspection at all reasonable time by the President, Medical Officer or any other Officer authorized by them, not below the rank of Overseer.

5. If the Medical Officer or the Health Officer certifies that for want of proper cleanliness or ventilation the state of any such house is dangerous or injurious to the health of the inmates, the President shall make such orders to remedy such defects as he may consider necessary.

6. Any person keeping a lodging house without a license as required by paragraph 2, or failing to comply with any order issued by the President under paragraph I, shall be liable on conviction to a penalty not exceeding Rs. 50 and to a further penalty of Rs. 5 for every day during which such offence is continued after such conviction, and the President may on such conviction cancel the license.

APPENDIX E.

Building Regulations enforced during the construction of houses in Fraser Town.

(1) That no house or enclosure of any description be erected without first submitting a plan of the same to the President and obtaining his sanction, *vide* Section 83 of the Bangalore Municipal Law.

(2) That no house shall cover an area larger than ½ the area of the land belonging to it.

(3) That a separate house be built for each separate family and no tenement house for more than one family erected.

(4) That the house be commenced within two months of purchase of land and completed within six months thereafter. In case of failure in the above without satisfactory explanation the plot to be resold at my risk.

(5) This agreement does not absolve me from all the other conditions prescribed by the Bangalore Municipal Law.

(6) That no large trees should be planted around the house.

(7) All the basement to be raised 1½ feet above the level of the street or road and to be built in stone and not in brick.

(8) The floors of all shops will be of stone with close fitting joints and a stone skirting 9 inches above the stone floor.

(9) The flooring of latrines will be of smooth Cuddapah stone with close fitting joints pointed in asphalte and the drains of portland cement ½ inch thick over three inches of concrete.

(10) The floors of all dwelling houses will be made of well-burnt hard flooring tiles or of stone laid with close joints and cemented so that no vermin or even white-ant can penetrate.

(11) All roofs are to be either terraced or of Mangalore tiles. Pot tiles and earthen roofs are strictly prohibited.

APPENDIX F.

I

In purchasing ....plots of land at the New Northern Extension for Rs..............I herewith pay Rs.... ....being ⅓ of the full value of the purchase money and hereby bind myself to pay the balance of Rs...... .... in two equal instalments of Rs .. ..each in 3 and 6 months from this date. In case of failure to pay one or both these instalments on the specified dates, I hereby agree and bind myself to forfeit all claim to the land and anything erected thereon and the Municipality may resume the land and dispose of it as it thinks fit, and also forfeit all moneys previously paid by me towards the purchase of this land.

I also agree not to sell, mortgage or otherwise alienate the land to any one till all the purchase money is fully paid.

The sanction which may be given for building on the land will not affect the above agreement.

II

In purchasing........ plot of land, I agree and bind myself to build .... house at the New Northern Extension on the following conditions :—

1. That no house or enclosure of any description be erected without first submitting a plan of the same to the President and obtaining his sanction, *vide* Section 83 of the Bangalore Municipal Law.

2. That no house shall cover an area larger than ⅓ the area of the land belonging to it.

3. That a separate house be built for each separate family and no tenement house for more than one family erected.

4 That the house be commenced and completed within eighteen months thereafter. In case of failure in the above without satisfactory explanation the plot to be resold at my request.

5. This agreement does not absolve me from all the other conditions prescribed by the Bangalore Municipal Law.

NATIONAL PRESS, BANGALORE.

Nos. 1345—1354.

FROM

THE HON'BLE MR. L. C. PORTER, C.I.E., I.C.S.,
Secretary to the Government of India,

To

THE CHIEF SECRETARY TO THE GOVERNMENT OF MADRAS.

,, SECRETARY TO THE GOVERNMENT OF BENGAL, MUNICIPAL (SANITATION) DEPARTMENT.

,, SECRETARY TO THE GOVERNMENT OF THE UNITED PROVINCES, SANITATION DEPARTMENT.

,, REVENUE SECRETARY TO THE GOVERNMENT OF THE PUNJAB.

,, SECRETARY TO THE GOVERNMENT OF BURMA, GENERAL DEPARTMENT.

,, SECRETARY TO THE GOVERNMENT OF BIHAR AND ORISSA, MUNICIPAL DEPARTMENT.

,, HON'BLE THE CHIEF COMMISSIONER OF THE CENTRAL PROVINCES.

,, HON'BLE THE CHIEF COMMISSIONER OF ASSAM.

,, HON'BLE THE CHIEF COMMISSIONER AND AGENT TO THE GOVERNOR-GENERAL IN THE NORTH-WEST FRONTIER PROVINCE.

Department of Education.
Sanitary.

Simla, the 26th July 1912.

SIR,

WITH reference to the letter from the Department of Education, no. $\frac{461}{463, \text{ etc.}}$, dated the 27th March 1912, I am directed to address $\frac{\text{the Government of } \frac{\text{Madras,}}{\frac{\text{Bengal}}{\text{etc.}}}}{\text{you}}$ on the question of general town planning which was one of the subjects discussed at the Sanitary Conference, Bombay.

No. 467 (to Bihar and Orissa and) to Assam.

2. The Government of India are of opinion that the question is one of great and increasing importance. The great majority of large Indian towns are surrounded by insanitary quarters which have been permitted to grow up without any attempt at control and which are often the starting grounds of plague and other diseases. A large population is crammed into an altogether inadequate space, and owing to the growing tendency of suburban landlords to refuse to let agricultural land for building purposes it is becoming more and more difficult to meet the increasing demand among large classes of the population for improved dwellings amid more sanitary surroundings.

3. The art of town-planning is of comparatively modern growth, and it is only recently that town-planning experts have arisen, in very small numbers even in Europe. The matter is therefore one in which progress must necessarily be slow, but the Government of India are of opinion that a beginning can be made by enquiries as to the necessity for town-planning legislation and the form which such legislation should take.

4. The Government of India believe that they are right in stating that nowhere in India has the question taken a practical shape except in Bombay where a general Town Planning Act is under consideration. The question was discussed at the First All-India Sanitary Conference which was held at Bombay in November 1911, and papers on the subject were read by Mr. Turner who attended the Conference as the delegate of the Government of Bombay. A copy of these papers which were published as appendices to the report of the Conference are enclosed [together with a memorandum suggesting the main lines on which an Act might be drawn up].

5. [The suggestions in the memorandum are based mainly on the provisions of the English Housing and Town Planning Act of 1909, and the proposals for redistribution (pooling of land of small owners and redistributing it in suitable building plots, less the portion required by the Municipal authority for road and open spaces and other public purposes) are taken from the German Act. Some such power appears to be necessary when planning building plots on land with diversified ownership as is peculiarly the case in India. In practice the major number of alterations would consist in clipping or adding small strips to the boundaries of existing holdings, or in joining two or more small contiguous holdings so as to make a plot of suitable size for building.] Mr. Turner's papers, to which special attention is invited, explain in detail the development contribution scheme, re-distribution and consequent transfer of rights. The principal feature of the scheme is that its whole cost is apportioned and recovered from the various persons and interests concerned in the shape of a development contribution calculated in proportion to the increased value which is estimated to accrue, on the completion of the scheme, to each reallotted plot; that it thus obviates, as far as possible, the necessity for raising capital, and secures for public purposes a share in the profits of the transaction.

6. The question of town-planning so far as it affects Indian cities appears to the Government of India to need examination from the following points of view, *viz.* :—

(*a*) The extension of existing towns.

(*b*) The improvement and opening out of existing insanitary areas in old towns.

The present reference deals mainly with the situation which is likely to be created by (*a*) and the Government of India propose to address local Governments shortly on the question of strengthening the existing powers of local authorities in dealing with existing insanitary areas. Where land on the outskirts of a town is mainly agricultural land and can be acquired cheaply *en bloc* it appears to the Government of India that the better policy would be for the local authority to purchase it outright and secure a return by premium and ground rents as buildings extend instead of depending on development taxes. But where an existing city has been allowed to grow up in a haphazard way with vested interests in its surroundings, the acquisition of land would of necessity be of a much more expensive and difficult character, owing to delays in litigation and the rise in prices of land. It is in such cases that it appears to the Govern-

ment of India that control would be preferable to acquisition, which indeed for financial reasons would, on a large scale, be impossible. The object of the suggestions now made is to render it possible to control future urban development and to provide for the expansion of population without imposing increasing burdens on the general revenues or the resources of local bodies such as are at present involved when urban land can be acquired only under the Land Acquisition Act.

7. The matter is, however, novel and complicated and the Government of India will be glad if it is fully and carefully considered and they are favoured with the mature opinion of $\frac{\text{His Excellency the Governor in Council}}{\text{His Honour the Lieutenant-Governor}}$ / your mature opinion as to (whether local legislation is possible or whether it is desirable to have an All-India Act on the subject) [whether an All-India Act on the subject is desirable].

Not to Bombay.
( ) to local Governments only. which have a local Council.
[ ] to Central Provinces, Assam, Coorg and North-West Frontier Province.

[They will also be glad to receive any suggestions on the scheme outlined in the revised memorandum, dated the 11th June 1912, which $\frac{\text{the Government of } \frac{\text{Madras}}{\text{Bengal}} \text{ etc.}}{\text{you}}$ may be able to offer.]

8. The question is one of considerable public interest and the Government of India will be glad to know whether in the opinion of $\frac{\text{His Excellency the Governor in Council}}{\text{His Honour the Lieutenant-Governor}}$ / your opinion it would be advisable to publish these papers at this stage, in order to elicit a general expression of opinion.

I have the honour to be,

SIR,

Your most obedient servant,

L. C. PORTER.

Secretary to the Government of India.

S G. P. O.—No. 1040 D. of E.—4-1-13—2030—T. P. M.

SHORT NOTE ON TOWN-PLANNING IN SALSETTE ISLAND.

The Bombay Government propose to introduce shortly a Town-Planning Act for developing the Bombay suburbs in Salsette Island which adjoins Bombay on the north. Details of town-planning schemes are being worked out by a special officer deputed for the purpose and the method being followed is similar to that contained in the German Act, the Lex Adikes, whose principal virtues lie in obviating as far as possible the necessity of raising capital and in providing for the redistribution of existing plots so as to render them more suitable for building purposes.

The method briefly described is as follows:—

All land within the area being planned is pooled and the local authority takes all land required for roads, markets and other public sites and the remaining land is divided into suitable building plots and allotted to the original holders. The allotted plots are distributed, as far as possible, in the same proportion as the original ownership. The main portions of the allotted plots are kept, as far as possible, in the same position as the original plots so as to reduce displacements of existing holdings to a minimum. All rights in the original plots are transferred, where possible, to the allotted plots and in other cases are extinguished by cash compensation or otherwise. All expenses incidental to redistribution and all costs of constructing roads and other works included in a scheme are obtained by a loan. Interest and sinking fund charges are met by the levy of a development tax upon owners in proportion to the individual benefits derived from the operation of the scheme. The benefit derived is found by estimating the "unearned increment" accruing to each holding on completion of the scheme. The estimate is liable to a certain amount of error, but, where the price of land is not too high, a slight error will not affect very materially the pockets of the holders.

2. The method above described may be applied to large or small schemes and to large or small areas. It can be applied to the construction of a single road or even to the mere rearrangement of plots neighbouring an existing road, and it may be applied to a large area for the purpose of acquiring all land required for public purposes. The method has been worked out on paper for an area of about one square mile at Santa Cruz, a suburb on the Bombay, Baroda and Central India Railway, about 12 miles from the Fort, Bombay, and a scheme has been tentatively drawn up which provides for the redistribution of plots, the construction of roads and provision of lands for a park, a dispensary, a municipal office, schools, a police station and a recreation ground. The individual cost in most cases in land and cash for all these benefits is estimated to be under 30 per cent. of the present undeveloped value of a holding. A small scheme, such as the construction of a single road, can be carried out, in a year and the whole development tax can be at once levied from all holders, but for a large scheme, where some years may elapse before all constructional works are completed, a portion of the tax need only be required from owners until those works which materially better their holdings are taken in hand.

E. G. TURNER, *I.C.S.*,
Special Officer, Salsette Building Sites.

NOTE ON REDISTRIBUTION OF PLOTS AND CALCULATION OF DEVELOPMENT TAX IN TOWN-PLANNING SCHEMES.

"Redistribution" may be defined as the pooling of plots of land belonging to different owners and the allotment to them, after making provision for lands required by the local authority, of plots reconstituted in more convenient form for building sites.

The reconstituted or allotted plots will all be provided with access on roads, either existing or proposed. The area for allotment of plots will be the original area included in the scheme diminished by the land taken for roads and other public purposes, so that, in general, the allotted plots will be of smaller area than their corresponding original plots. When roads are actually constructed an allotted plot will increase in value, and the amount or such increase measures the "unearned increment," from which the costs of construction and other expenses of a scheme should be defrayed. The difference in value at any particular instant—such as at the date of a notification—between an original plot and its corresponding allotted plot, valued without reference to future improvements contemplated in a development scheme, represents a material contribution in land by the plot holder of which account must be taken in calculating the dues leviable. If the allotted plot as so valued is of less value than the corresponding original plot, the plot holder must be given credit for the difference, and if of greater value, then the plot holder must be debited with the difference. In this way, credit is given for the value of any land taken from an original plot; and debit is made for the value of any land added to it. No cash on this account passes between the holder and the local authority, but debit and credit are made against the holder's contribution for constructional and other expenses of the scheme. A holder's contribution share should be proportional to the amount of his "unearned increment," *i.e.*, to the difference in values of his *allotted* plot, when valued without reference to future developments, and when valued on the assumption that the scheme has been completed. The former may be called the "undeveloped" value and the latter the "developed" value of the allotted plot. The developed value is only an estimate, it is true, but any slight error in the estimate will not affect a holder's pocket very materially unless the price of land is very high. The expenses of a scheme must include the nett total difference in value between all the original plots and the undeveloped values of all the allotted plots, for this difference represents an immediate and material contribution in land to the scheme by the holders and its value should be shared by all in proportion to their "unearned increments."

2. The above method of calculating the contribution share is *absolutely independent* of the system on which the reconstituted plots are allotted; for every holder is given full credit for the present value of the land taken from him.

The German Act (Lex Adikes) lays down that the plots should be allotted *as far as possible* in proportion to original ownership.

If the proportion refers to relative *areas* there is necessarily a large displacement of plots, that is to say, many of the allotted plots cannot be in the same position as the main portions of their corresponding original plots, and if the proportion refers to relative *values* it is often a hopeless puzzle to arrange so that the developed values of the majority of the allotted plots bear *inter se* anything like the same ratios as the values of the original plots bear to one another. Only in a homogeneous tract of undeveloped land is there a chance of successfully allotting plots bearing *inter se* as far as possible either given proportional areas or given proportional values.

For a successful redistribution the main portions of the allotted plots should be generally in the same positions as the main portions of their corresponding original plots or in other words plots should be displaced as little as possible. Whole plots included in land required for roads and other public purposes must be displaced, but other plots should keep their position as far as possible. No hard-and-fast rule need be laid down for the way in which the reconstituted plots should be allotted, but the allotment should be made in consultation with the holders and should be approved either by the holders of the major portion of the area considered or by a controlling authority or by both.

3. Simple *example* showing the above method for calculating the contribution share.

Three plots X, Y, Z are to be developed by the construction of a road costing 900 rupees, the costs of preparing the scheme being 100 rupees :

Plot.	Value of original plot.	Value of allotted plot.		Unearned increment 4—3.	Difference between columns 3 & 2.
		Undeveloped.	Developed.		
1	2	3	4	5	6
X	100	80	200	120	—20
Y	200	250	600	350	50
Z	300	250	350	100	—50
Total	600	580	1,150	570	—20

To find the dues leviable upon X, credit must be given for R20 (column 2—column 3) and it must bear in proportion to its unearned increment (column 5) a share of the total expense R1,000, and also a share of the nett difference between the values of the original and undeveloped allotted plots, *i.e.*, R20 (column 6). That is to say the contribution leviable on X is—

$$-20+\frac{120}{570}(1{,}000+20) \quad . \quad . \quad . \quad . \quad =194{\cdot}74 \text{ R}$$

In the same way Y's share is—

$$+50+\frac{350}{570}\times 1{,}020 \quad . \quad . \quad . \quad . \quad =676{\cdot}32$$

and Z's share is—

$$-50+\frac{100}{570}\times 1{,}020 \quad . \quad . \quad . \quad . \quad =128{\cdot}95$$

Total . 1,000

4. *Development tax.*—Instead of levying the full contribution at once from each holder, the whole sum required for expenses can be borrowed and a percentage of such holder's contribution levied annually sufficient to pay interest and sinking fund charges on the loan. This percentage of contribution is the *development tax.* In small schemes where all constructional works are likely to be completed within a year, the full development tax can be levied simultaneously from all holders, but in larger schemes where constructional works are likely to take some time to complete, then it will only be necessary to meet in each year the sum required for works to be undertaken in that year. In this case a portion only of the development tax need be levied on those allotted plots which have not materially benefited by the works already constructed. *To take a concrete example* :—Suppose there are 100 plots and the total expenses are 50,000 rupees of which 10,000 rupees must be met at once and 40,000 rupees are for new roads. Then the full development tax is found by distributing the 50,000 rupees amongst all allotted plots in the proper proportion. But if it be only possible to construct roads each monsoon to the extent of 10,000 rupees, the scheme will take 4 years to complete and there is no need to raise more than 10,000 each year for new roads. The 10,000 rupees to be met at once can be obtained by levying $\frac{1}{5}$th full development tax on all allotted plots, and the 10,000 rupees required annually for new roads can be obtained by levying the full tax upon those allotted plots which front the roads constructed during the year. If the full tax levied upon such frontage plots is not sufficient to raise the 10,000 rupees required, the general tax of $\frac{1}{5}$th can be increased and if the full tax on frontage plots exceeds the 10,000 rupees required then the requisite proportion of the full tax need only be levied on the frontage plots, the levy of the difference being deferred until it is required. Even whilst paying the $\frac{1}{5}$th development tax the holders are distinctly benefited, for they will all possess saleable plots suitable for building and upon which building will be allowed and will all have proper access to their plots over public land.

5. *Compensation by debentures.*—It may happen that a holder's share of expenses is less than the difference in value between his original and undeveloped allotted plot or in other words is less than the value of his contribution in land. In such a case instead of paying a development tax to the local authority the holder will have to be compensated. He can either be paid cash down, or be given a debenture guaranteeing him interest and sinking fund charges on the amount to be paid to him. The issue of such a debenture will reduce the capital to be raised in the open market. Full security, however is present whether compensation is paid to such a holder either in cash or by debenture.

Example.—The contribution leviable from A, B, C, D, are as follows :—

	R
A	500
B	600
C	—300
D	200
	1,000 nett.

If C is compensated at once, a capital of R 1,300 will have to be raised on the security of the amounts due from A, B, D. If C is compensated by debenture only 1,000 rupees capital would have to be raised in the open market, and interest and sinking fund charges would be collected from A, B, D as before on R1,300 by means of a development tax.

The system of payment by debentures is capable of extension, and some persons would possibly prefer being paid by a saleable debenture ensuring steady interest, instead of being paid cash down.

6. *Incidence of taxation.*—The development tax should be fixed for each allotted plot, so that when a plot is sold a purchaser will know exactly with what taxes the plot is burdened. Some holders may have several separate original plots and it may not be possible to allot a separate plot for each original plot. In such a case the total contribution of the holder can be calculated and distributed over his allotted plots in proportion to their unearned increments.

Example.—A holder has plots of the following value :—

Value of original plot.	Undeveloped value of allotted plot.	Developed value of allotted plot.	Unearned increment, 3—2.
1	2	3	4
R	R	R	R
1,000	2,000	3,000	1,000
2,000	4,000	7,000	3,000
3,000	2,000	5,000	3,000
4,000	....	....	...

If the holder's contribution is R700 then it will be divided amongst the allotted plots in the proportion of 1,000 : 3,000 : 3,000, *i.e.*, the burden on the plots will be R100, R300 and R300 respectively.

7. Formula for calculating contribution share —

Let

a_o = Value of original plot.

a = Undeveloped value of allotted plot.

A = Developed value of allotted plot.

X = Constructional and all expenses of the scheme debitable to holders other than the nett compensation to be credited to holders for land surrendered. (*Vide* para. 1.)

The holder's contribution share is equal to—

$$(a - a_o) + \frac{A \quad - a}{EA - Ea} [X + E\,(a_o - a)]$$

where E is a symbol representing the sum total of the quantities of the type to which it is joined. The fraction $\frac{X + E\,(a_o - a)}{E \quad - Ea}$ forming a portion of the second member of the expression is easily calculated for any particular scheme, and remains constant in calculating the share of each and every holder. If we denote this fraction by K then the share is equal to $(a - a_o) + K\ (A - a)$ which simply means that a holder is given credit for the present value of the land he surrenders $(a - a_o)$, and pays the proportion K of his unearned increment (A—a) towards the expenses of the scheme. The nett total of all contributions is equal to X. If *A* and *a* are proportional to a_o, that is to say, if the developed and undeveloped values of an allotted plot are each proportional to the value of the original plot then the contribution share is proportional to the value of the original plot, and if these proportions obtained in respect of all the plots then there is no need to value the allotted plots as undeveloped. In a small scheme therefore, such as the construction of a small accommodation road where it may happen that all original plots are reduced at once in value in the same proportion, and when they all increase in value of the same proportion on completion of the

scheme, the contribution shares can be found by dividing up expenses in proportion to the differences between the developed values of the allotted plots and the values of their corresponding original plots.

8. *Practical application* of this method of allotting plots and calculating the development tax has been made tentatively on paper to a large partially developed area, about one square mile at Santa Cruz, a suburb of Bombay. This scheme comprises the acquisition and construction of about 3 miles of roads of varying widths and 1 mile of sweepers passages 10 feet wide. The public sites for acquisition comprise those for—

a Park,
Municipal Office,
Dispensary,
Girls' and Boys' Schools,
Police station,
Market,
Lawn Tennis ground,
Dharmshalla,

and the existing roads are widened where necessary. After allowing for possible local fund and Government grants the nett total cost of the scheme to be met by holders is estimated at R1,50,000. The capital to be raised is calculated at R1,52,000, the extra R2,000 representing compensation to be paid to those holders whose contribution in land is greater than their share of expenses (*vide* para. 5 above). The construction of roads will probably take five years to complete, and the initial expenses can be met and road construction started by the levy of 12 per cent. only of the full development tax. A holder's full contribution in land and cash together is found to be about ⅓rd or less of the present value of his original plot, and the ratio of such contribution to the increase in the value of his holding, *i.e.*, to the difference between the developed value of his allotted plot and the value of his original plot, is found not to exceed 60 per cent. In most cases it is much less.

9. In conclusion it must be stated that the method of calculation described in this note has not yet been sanctioned. A Town-planning Bill has not yet been brought forward in the Bombay Legislative Council. Many methods of calculation have been tried on paper, but the method above described is the one which in my humble opinion is practical, and provides *an absolutely equitable system* of distributing expenses.

E. G. TURNER, *I.C.S.*,
Special Officer, Salsette Building Sites.

Transfer of rights.

I think that if a holder and other persons interested in a plot come to an agreement in respect of their rights in the allotted plot, the arbitrator should be bound to accept such agreement unless its terms are prejudicial to the objects of planning. It should also be open to a holder to demand that a lease to cultivate should not be transferred. The holder will then be in a position to use his plot to building purposes, and he will naturally be charged with the cost of determining the lease. Again, a cultivating tenant should be able to claim that his lease should determine in cases where the land of the allotted plot is not of the same agricultural kind as that of the original plot. A cultivating tenant of a rice field should have the option of refusing to have his lease transferred to an allotted plot consisting of garden, land or a mango grove.

4. *Leases*—

If a lease is extinguished or modified it is clear that compensation must be paid to the Lessee. Take the case of the Government acquiring land for a road under the Land Acquisition Act. An owner would be paid the market value of the land taken and the lessee would be paid for the loss caused by having a portion of his leased land taken from him. The lessee would also demand to pay less rent to the owner or be further compensated if he is compelled to pay the old rent in the future. In the latter case the owner would have to pay the compensation to the lessee, for he would be receiving rent for land that had been bought from him by Government. The remaining compensation payable to the tenant would be borne by Government.

Example:

A is the owner of 1 acre of homogeneous cultivable land leased to *B* at a yearly rental of R60 and the lease has 5 years to run. Government acquires under the Land Acquisition Act one-tenth acre of this land for a road. Let the market value of the holding be R600. *A* would be awarded the market value of one-tenth acre, *i.e.*, 60 rupees and would in future be entitled to receive only R54 rent from *B*. If, however, no alteration in rent is made and *A* continues to receive the rent of R60, then *B* must be given as compensation the present value of R6 a year payable for 5 years, and the market value payable to *A* must be reduced by that amount. When a portion of a leased plot is taken for a road under the Land Acquisition Act, the tenant retains his right on the remainder of the plot. Now, as the price of land rises on the construction of a road, it will generally pay the owner to get rid of his tenant and utilize or sell his land for building purposes. In order to do this, the owner would have to pay out the tenant at his own expense. If, therefore, the Town-Planning Act gets this done for him it is only right that he should be debited with its cost. The cost of extinguishing a lease therefore should be debited to the Town-Planning Scheme and the owner of the original plot in such proportion as the arbitrator may determine in reference to the portion of the *original* plot taken by the local authority and the remaining portion of the original plot (*vide* section 15 Lex Adikes).

Example:

In example 1 the cost of compensating *B* extinguishing his lease would be borne by the scheme and the owner in the proportion of 1 to 9.

If a whole plot is taken for public purposes and no reconstituted plot can be allotted, then the whole cost of extinguishing a lease would be a cost of the scheme. If no portion of a plot is taken for public purposes then the whole expense of compensating a tenant for a lease that must be extinguished would fall on the owner.

On redistribution day all leases on original plots determine, and some leases—either in their original or in a modified form — are imposed on the allotted plot. The loss to the lessee by the transfer can be calculated by the arbitrator. The portion of this loss debitable to the scheme is calculated as stated above in reference to the portion of the *original* plot taken by the local authority and the remaining portion of the original plot. The remaining portion of the lessee's loss must be borne by the owner.

Example:

In example 1 the arbitrator calculates that —

(*a*) the loss to the lessee by transference to the allotted plot is R60;

(*b*) the cost to the scheme by extinguishing the lease of the original plot is R10.

The owner will therefore be debited with R50 (60 less 10) as his share of compensation towards the loss sustained by the lessee.

It may happen that a lessee gains by having his lease transferred *in toto* to an allotted plot, *i.e.*, an allotted plot may be simply the original plot slightly enlarged so as to round it off. In such a case the arbitrator could either increase the rent payable by the lessee or allow the lessee rights over a portion only of the allotted plot.

Mortgage without possession.

5. If the present value of an allotted plot with reference to the improvements contemplated is of greater value than the original plot, the mortgage can be transferred without loss of security. If a scheme is to be successful this will usually be the case. It may, however,

happen, that an allotted plot as valued above is less than the value of the original plot. If the mortgagee accepts the allotted plot as his new security then all is well, but if he does not then the whole or any part of the difference in values between the original plot and the allotted plot (valued as undeveloped) instead of being credited to the holder, should be paid to the mortgagee in whole or part satisfaction of the mortgage.

Example. :	R
(a) Value of original plot	300
(b) Amount due on mortgage	200
(c) Undeveloped value of allotted plot	100
(d) Present value of allotted plot in reference to improvements contemplated	150

Instead of crediting the holder with R200 (a)—(c) it may either be paid to the mortgagee and the mortgage thereby redeemed or the holder may be credited with R150 only instead of 200 rupees and R50 each could be given to the mortgagee and his mortgage transferred to the allotted plot.

Mortgage with possession.

6. These are usually either one or other of the following two kinds :—

(a) The use of the land is given to the mortgagee for a certain number of years in full repayment of the mortgage.

(b) The mortgagee holds the land and reaps the profits on it by way of interest on his loan.

Case (a) is precisely similar to a lease by the mortgagor to the mortgagee for a definite number of years and can be treated in the same way.

Case (b).—The mortgagee will be satisfied if he gets at least equal security and an equivalent for the secured profits. Equal security can be given as in the case of a mortgagee without possession, but the mortgagee may not in all cases be able to utilize the allotted plot so as to secure him the same profits as the original plot yielded. For any such loss of profits he is entitled to some equivalent at mortgagor's cost and for any increase of profits the mortgagor entitled to credit. A rocky piece of ground allotted in lieu of a cultivable plot will not always be of use to a mortgagee in possession, for even if the mortgagor consents to the mortgagee erecting buildings on the rocky land it may not pay the mortgagee to erect a substantial structure and the scheme may not permit of huts being erected. The best course in such a case would be to compensate the mortgagee at the mortgagor's expense for loss of possession and to put the holder (mortgagor) in possession of the allotted plot, thereby converting the mortgagee with possession into a mortgage without possession. Any amount paid to the mortgagee would go in part satisfaction of the mortgage. In cases of difficulty the original plot should be bought up and allotted to others.

7. In cases where a plot is heavily encumbered it may happen that the nett total liability on an allotted plot may exceed the development value of the allotted plot.

Example.	R
(a) Value of original plot	1,000
(b) Undeveloped value of allotted plot	800
(c) Developed value of allotted plot	900
(d) Proportion of "unearned increment" demanded for expenses	..
(e) Cost debitable to holder for extinguishing or transferring rights in his original plot.	1,100

The total liability of the allotted plot is therefore $1{,}100-200+\frac{1}{3}(900-800)=900+33\frac{1}{3}=933\frac{1}{3}$.

In such a case the holder should be given the option of paying 33 rupees cash down—thereby giving the local authority full security for the development tax, or his original plot should be bought up and allotted to others.

If the nett liability of a reconstituted plot exceeds its developed value, such plot should not be allotted unless the holder of the corresponding original plot pays such excess to the local authority for credit to the scheme. On failure to pay such excess within a specified time the whole of the original plot shall be liable to be acquired for the local authority at the value fixed by the arbitrator, and the reconstituted plot shall be allotted to the local authority. The cost of acquiring such portion of the original plot as may not be taken for public purposes shall not be a cost of the scheme.

E. G. TURNER, *I.C.S.*,
Special Officer, Salsette Building Sites.

S. G. P. I.—No. 1040 D. of E.—13-1-13—P. J. M.—2030.

MEMORANDUM.

The general principle of a town-planning scheme is that a scheme is prepared for a given area, distributing the land with which it is concerned to such and such uses, this scheme is notified and discussed and settled, and after it is settled owners are bound to conform to it. The following suggestions indicate generally the lines which legislation might follow.

1. A Town-Planning Act to be enacted, capable of extensions to any given area by order of the Local Government.

2. A local authority to be constituted for such area with power to make a town-planning scheme. Such local authority to be appointed by the Local Government. This local authority to be subject to a controlling authority, similarly appointed.

3. The local authority to be empowered to declare by notification, in the manner prescribed, its intention to make a town-planning scheme for the whole or any part of such area; the notification to be accompanied by such general plans and information as may be prescribed by rules.

Such declaration to be made, with the previous sanction of the Local Government, either *suo motu*, or by order of the controlling authority.

4. The scheme to provide for any or all of the matters referred to in the schedule to the Act and such other matters not inconsistent with the purposes of the Act as may be prescribed and to be accompanied by such plans and estimates as may be prescribed by rules under the Act. Such matters would be the construction, diversion and alteration of roads and communications, the construction and alteration of buildings, bridges and other structures, the plotting out of land as building sites, whether intended for building in the immediate future or not; the reservation of land for open spaces, gardens, recreation grounds, schools, markets and public purposes of all sorts; drainage, lighting and water-supply, the preservation of objects of historical interest or natural beauty, prescriptions as regards the number and nature of buildings allowed in specified areas and the purposes to which specified areas may or may not be appropriated.

5. The scheme to apply to land which is or is likely to be used for building purposes. Land likely to be used for building purposes to include any land likely to be used for the purpose of providing open spaces, roads, streets, parks, or for the purpose of executing any work upon or under the land incidental to a town-planning scheme. The scheme to be capable of extension to a piece of land not likely to be used for building purposes, which is so situated with regard to any land likely to be used for building purposes that in the opinion of the controlling authority it ought to be so included and the controlling authority to be authorised to include in the scheme provisions for the demolition or alteration of any buildings thereon as far as they may be necessary to carry the scheme into effect.

Cf. section 54 (*f*), Housing and Town-Planning Bill.

6. Within a period to be prescribed of the notification of the declaration to make a town-planning scheme the local authority, with the approval of the controlling authority, and in default of the local authority the controlling authority, to publish a block scheme and plan for the area included in such declaration.

7. *Contents of scheme.*—Power to be given to prescribe generally by rules under the Act the information to be contained in the block scheme, and the plans and estimates to accompany it. In particular to prescribe that the scheme should specify the restrictions to be imposed on the number of buildings to be erected on a given area, and the height and character of those buildings, and should contain estimates of the cost of the scheme; total of development contribution to be distributed over the area left with, or allotted under redistribution, to the owner; and other details necessary for a full comprehension of the scheme.

8. *Discussion of the scheme.*—Provision to be made by rules under the Act for securing co-operation on the part of the local authority with the owners and other persons interested in the land proposed to be included in the scheme at every stage of the proceedings, by means of conferences or such other means as may be prescribed.

9. *Provision for reconstitution*—

(*a*) No plot to be included in the block scheme and plan on which building will not be permitted.

(*b*) The local authority to be empowered to propose and the controlling authority to sanction the alteration of the boundaries of the original plots so as to render them more suitable for building purposes; in order to provide plots to be held under joint ownership with the consent of the parties concerned; in order to provide plots for owners dispossessed from land required by the local authority, and generally to further the objects of the scheme.

(*c*) Rights in original plots to be transferred wholly or in part to reconstituted plots so far as they are capable of being transferred without prejudice to the objects of the scheme; rights which are not capable of being transferred to be extinguished; compensation to be payable by the local authority and the owners in such proportion as may be determined by the arbitrator subsequently mentioned to owners of rights injuriously affected by transfer or extinction.

Provided that agricultural leases should not be transferred to the reconstituted plots without the consent of all parties to the lease, and all rights in property acquired by the local authority should be extinguished.

10. Objections to the block scheme and plan to be made within a prescribed period by owners of the lands comprised therein and to be considered by the local authority.

11. The scheme to be submitted for approval to the controlling authority with a statement of the objections thereto, provision being made for hearing all parties interested at this stage also. After approval the scheme to be notified. The controlling authority, before granting sanction, to be empowered to make such alterations as may seem fit.

12. After declaration of intention to plan all buildings and works in contravention thereof to be prohibited. After such declaration no person to be permitted to commence or proceed with any building or carry on any work or do anything which in the opinion of the local authority is in contravention of the scheme without a certificate from the local authority.

The local authority to have power to remove, pull down, destroy, stop, or alter any building or work begun or proceeded with which in whole or part in the opinion of the local authority, to be recorded in a finding, contravenes the scheme, or for which a commencement certificate has not been obtained.

Cf. clause 56 (1) of Housing and Town-Planning Bill.

No person to be entitled to compensation for such action, and expenses incurred by the local authority to be recoverable from the persons in default. But compensation to be claimable as regards work done before the date of notification of the block scheme for the purpose of finishing a building begun, or executing a contract entered into before the date of declaration of intention to prepare a town-planning scheme. Any question arising as to whether a building contravenes a scheme, or whether any provision has not been complied with, to be determined by the local authority.

13. *Finance*—

(*a*) The costs of the scheme to include all sums spent in the preparation and execution of the scheme, including all sums payable by the local authority not specifically excluded, and including the nett difference in value between all the original and all the allotted plots as valued at the date of declaration of intention to plan without regard to prospective development.

If in any case the total value of the allotted plots exceeds the total value of the original plots estimated on the above basis, the amount of such excess to be deducted from the cost of the scheme.

(*b*) The costs of the scheme to be met by a contribution to be levied as follows on all allotted plots :—

(1) The original and allotted plots to be valued as at the date of declaration without considering any enhancement of value due to prospective development.

(2) When the value of the allotted plot valued on this basis is less than the value of its corresponding original plot, then the amount of contribution leviable on the allotted plot will be reduced by the amount of the difference. When it is greater, the amount of contribution will be increased by the difference.

(3) The whole cost of the scheme will be divided amongst all the allotted plots in proportion to their increase in value when valued in accordance with (1) and when valued on the assumption that the scheme has been completed.

(4) When a plot is subject to a mortgage or a lease the arbitrator subsequently mentioned to determine in what proportion the mortgagee or lessee and owner shall pay the contribution.

(5) The contribution shall not exceed one-half the increase in value estimated to accrue to the plots under (3).

(6) All payments to be made so far as possible by adjustment of accounts in respect of the plot concerned, or any other plot in which the owner has an interest. In case the amount payable to an owner exceeds the amount due from him, the difference to be paid him in cash, or by any other arrangement which the local authority may make with his consent.

(7) The net amount due by owners may be paid in a lump sum at the option of the contributors or in such instalments as the local authority may fix with the sanction of the controlling authority.

14. After the block scheme has been approved the controlling authority to appoint an independent arbitrator whose duty shall be to draw up the final scheme and plan in accordance with the block scheme and plan.

(1) He will estimate the value of holdings at the date of declaration of intention to prepare a scheme, and the undeveloped and developed value of holdings allotted.

(2) Demarcate *in situ* the reconstituted plots, and the land required by the local authority and show boundaries.

(3) Determine the allotment of reconstituted plots and regulate the transfer or modified transfer of existing rights in reconstituted plots and fix compensation for rights modified or extinguished.

(4) Award compensation payable for rights injuriously affected by the scheme. No such compensation to be payable if provisions of such scheme are such as would have been enforced without compensation if contained in bye-laws made by the local authority under any other Act in force.

No property deemed to be injuriously affected by reason of any provisions inserted in a scheme prescribing amount of open space to be maintained about buildings, or limiting number of buildings or prescribing their height or character.

(5) Calculate the contribution payable on the allotted plots in proportion to their undeveloped value.

15. No suit to be filed in a civil court in support of any claim which might have been made before an arbitrator.

16. The arbitrator will draw up and forward to the local authority the final scheme and plan.

17. The local authority will then notify the final scheme and plan, which will have effect as if it were enacted in the Act. After notification the local authority to have power to enforce the scheme, recovering the expenses from the persons in default.

18. All decisions of the arbitrator to be final, but the controlling authority on receipt of an application made within 3 years by the local authority or the owners of plots comprising more than ½ the area of the final scheme to appoint a second arbitrator to revise the valuation of holdings, made on the assumption that the improvements contemplated by the scheme have been completed.

19. A local authority as defined in the Act to be deemed to be a local authority as defined in the Local Authority's Loan Act, 1879, for the purposes of borrowing money under the Act and the execution of a town-planning scheme to be deemed to be work which such local authority is legally authorised to carry out.

20. Power to be given to the Local Government to make rules regulating procedure.

Nos. 1480—1488.

FROM

THE HON'BLE MR. L. C. PORTER, C.I.E., I.C.S.,

Secretary to the Government of India,

To

THE SECRETARY TO THE GOVERNMENT OF MADRAS,
MUNICIPAL DEPARTMENT.

" SECRETARY TO THE GOVERNMENT OF BENGAL,
MUNICIPAL DEPARTMENT.

" SECRETARY TO THE GOVERNMENT OF THE
UNITED PROVINCES,
MUNICIPAL DEPARTMENT.

" REVENUE SECRETARY TO THE GOVERNMENT
OF THE PUNJAB,
MUNICIPAL DEPARTMENT.

" SECRETARY TO THE GOVERNMENT OF BURMA,
MUNICIPAL DEPARTMENT.

" SECRETARY TO THE GOVERNMENT OF
BIHAR AND ORISSA,
MUNICIPAL DEPARTMENT.

" HON'BLE THE CHIEF COMMISSIONER
OF THE CENTRAL PROVINCES.

" HON'BLE THE CHIEF COMMISSIONER OF ASSAM.

" HON'BLE THE CHIEF COMMISSIONER
AND AGENT TO THE GOVERNOR-
GENERAL, NORTH-WEST FRONTIER
PROVINCE.

Simla, the 9th August 1912.

Department of Education.
Municipalities.

SIR,

WITH reference to paragraph 6 of this Department letter nos. 1345-54, dated 26th July 1912, in which suggestions were made for the introduction of a Town-planning Act, applicable to new areas in large and growing towns, I am directed to address the Government of Madras / Bengal, etc. / you on the subject of the improvement of existing congested areas in old towns.

1041 D. of E.

The evils of overcrowding and insanitary dwellings which exist in all great cities are intimately connected with the high death rate and especially with the alarming spread of tuberculosis. No real progress in urban sanitation is possible unless these conditions can be radically improved; and it appears to the Government of India that while, on the one hand, local bodies fail in many instances adequately to administer the existing provisions of the Municipal Acts, in many other respects the powers they possess are insufficient for dealing satisfactorily with insanitary areas and houses.

3. It will be convenient to recapitulate briefly the chief provisions of the English Housing of the Working Classes Act, 1890 (amended by the Housing, Town-planning, etc., Act, 1909), dealing with:—

(1) Improvement schemes for areas which have been declared insanitary, the compulsory acquisition of land in connection with such schemes, and the settlement of compensation for acquisition.

(2) Obstructive buildings, *i.e.*, buildings which stop or impede ventilation or make other buildings unfit for human habitation or which prevent proper measures from being carried into effect for remedying any nuisance injurious to health.

(3) Buildings unfit for human habitation.

4. I. (*a*) *Insanitary areas and improvement schemes.*—The provisions dealing with these matters in the English Act* are intended to be set in operation by the medical officer of health to the local authority who is empowered to represent that a local area is in such an insanitary state that an improvement scheme for the reconstruction of streets or houses, or some of them, is necessary.

* Housing of the Working Classes Act, 1890.

If twelve or more rate-payers make a representation the medical officer is bound to inspect and to make an official representation to the local authority.

The local authority must consider the report, and, if satisfied of the truth of it, they must declare the area unhealthy and prepare an improvement scheme.

If they disagree they are bound to report their reasons to the local Government Board, which may order them to prepare and carry out the scheme. These provisions have been generally followed in Chapter III of the Calcutta Improvement Act, 1911.

(*b*) *Compensation for acquisition.*—Compensation for land acquired under Part I of the English Act, which deals with improvement schemes is determined by an arbitrator appointed by the confirming authority subject to an appeal to a jury in cases when the sum found due exceeds £1,000. Under section 21 of the Act compensation is payable at an estimate of fair market value, without any additional allowance in respect of the compulsory purchase of any area or any part thereof which has after enquiry been declared to be an unhealthy area, and it is further provided that in assessing compensation the arbitrator may take into consideration the fact that a house is rack rented or in an insanitary condition or unfit for human habitation and reduce the compensation accordingly. Similar provisions are contained in the Calcutta Improvement Act, 1911, the schedule of which modifies the Land Acquisition Act as applicable under the Act and in particular provides no additional compensation for compulsory acquisition.

Housing of the Working Classes Act, 1890.

II. *Obstructive buildings.*—Section 38 of the English Act of 1890 provides for the acquisition of obstructive buildings as defined above. The medical officer makes a representation to the local authority when he considers such a building should be demolished, and four rate-payers may also take similar action. If the local authority after hearing the owner decide to proceed, they must acquire the building and land. Compensation is determined by an arbitrator appointed by the local Government Board, and similar provisions against excessive compensation are enacted as in section 21 of the Act. There is a further provision by which the arbitrator may apportion the compensation among the other surrounding houses to the extent to which they are increased in value by the demolition of the obstructive building, and the same may be recovered by the levy of a private improvement rate.

Vide section 38 (8) and (9) of the Act of 1890.

The owner may claim to retain the site in which case the local authority are only bound to pay compensation for the building. In such a case no building which may be obstructive can be erected on the site. The local authority are also not bound to purchase the entire holding if, in the opinion of the arbitrator, a part can be severed without material detriment to the remainder. If the local authority fail to give effect to any order as regards an obstructive building, the local Government Board have power to require them to do so. The award of the arbitrator is final and binding on all parties.

III. *Unhealthy dwelling houses and power to deal with buildings unfit for human habitation.*—Under section 17 of the Housing, Town-planning, etc., Act, 1909, regular inspections have to be made and records kept of these inspections and of action taken on them by the local authority with a view to ascertaining whether any dwelling house is in a state so dangerous or injurious to health as to be unfit for human habitation. The inspections are made by the medical officer of health and he is obliged to report annually to the local Government Board the inspection made and the action taken. Detailed regulations to this effect have been made by the local Government Board. If the local authority have failed to take necessary action, an order may be made requiring them to do so and this order may be enforced by *mandamus*. If a house is shown to be unfit for human habitation, a closing order is made prohibiting its use, until put into a sanitary condition. An order becomes operative at the end of 14 days if no appeal is made to the local Government Board. When it becomes operative, notice is issued to the occupying tenants to quit within 14 days, and they can be summarily ejected at the close of that time. When an order has remained operative for 3 months and has not been complied with, after notice to the owner (who is given another opportunity of putting the house in order), a demolition order can be made and the expenses of demolition recovered from the owners.

5. No doubt some of these provisions are more suited to the conditions of an advanced western country than to India. But it appears to the Government of India that the provisions of the existing Acts might, in many instances be strengthened, and extended powers conferred on selected Municipal bodies to deal with these matters on similar lines.

It is possible that a similar power of initiative to that conferred on medical officers of health in England might in India be entrusted to Deputy Sanitary Commissioners in provinces where such officers exist; and that failing action by the local bodies power of effective intervention might be reserved by the local Government. The prohibitive cost of acquiring congested areas in large cities, and the necessity of contesting every disputed case in the Civil courts, prevent in practice effective action on the part of many Municipal bodies in dealing with slum areas. The provisions of the English Act limiting excessive compensation in areas, which after due enquiry, have been declared insanitary, appear to the Government of India to be just and reasonable, and they have already been incorporated in the Bombay and Calcutta Improvement Acts. By the appointment of an arbitrator whose decision in the majority of cases is final, a swift and sure procedure is provided for the settlement of disputed cases.

With regard to the acquisition and demolition of "obstructive" buildings the Government of India desire to draw particular attention to the provision of the English Act of 1890 [section 38 (8)] by which a contribution towards the net cost of acquisition and demolition of the obstructive property can be recovered from the owners of the properties benefited by the demolition. It appears to the Government of India that by the enactment of a similar provision the cost to the public purse could be materially reduced.

Buildings unfit for human habitation can be closed until fit for occupation under the provisions of all Indian Municipal Acts, but there is reason to believe that these provisions are rarely enforced. A possible remedy to this neglect might be found on the lines of sections 11 and 17 of the Housing and Town-planning Act of 1909 which enforce regular inspection with report of action taken, and reserve power to the local Government Board to intervene in case of default. But the provisions in the majority of Indian Acts are not so effective as in the English Statute and in particular no power is given to demolish when a closing

order remains inoperative. Further it appears to the Government of India most desirable to give power to local bodies to declare any *room* which fails to reach a prescribed standard of lighting and ventilation unfit for human habitation, and to veto the occupation of such rooms under substantial penalties.

6. Finally the Government of India consider it important that building bye-laws in the larger cities should be carefully examined with a view to their being made generally more efficient and with special reference to the provision of sufficient outside air space for every room. In the view of the Government of India, the first essential for future progress is to fix a standard of light and ventilation and then to ensure that this standard shall be enforced and no building permitted in contravention thereof. The Government of India hope that the difficulties felt in the past owing to the lack of trained agency, will be lessened as the scheme of reorganisation sanctioned in their circular letter nos. 2094-3001, dated the 10th November 1911, is generally made effective in urban areas. The Government of India will be glad if they may be furnished in due course with the views of His Excellency the Governor in Council / His Honour the Lieutenant-Governor (in Council) / your views on the suggestions contained in this letter. They also think that the whole question of improvement of congested areas and other matters raised in this letter might appropriately be discussed at the next All-India Sanitary Conference at Madras and they will be glad if with the permission of His Excellency the Governor in Council / His Honour the Lieutenant-Governor (in Council), the delegates from the various provinces are informed accordingly.

I have the honour to be,

SIR,

Your most obedient servant,

L. C. PORTER,

Secretary to the Government of India.

No. 1489.

Copy forwarded to the Sanitary Commissioner with the Government of India for information.

By order,

MAHARAJ SINGH,

Assistant Secretary to the Government of India.

S. G. P. O.—No. 1041 D. of E.—4-1-13—2030—T. P. M.

HOUSING OF THE WORKING CLASSES IN LARGE CITIES IN INDIA.

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During the past few years the problem of housing and town-planning has developed enormously in England by the passing of the Housing and Town Planning Act, 1909, which deals with—

(a) extension of existing towns;
(b) the improvement and opening up of existing insanitary areas in old towns.

I propose to make a few remarks on (b) as it is that part which comes more intimately into touch with the work of a Health officer and has a close bearing on the subject of this paper.

In India at present the provisions of Acts and by-laws for the improvement of towns, old or new, are so weak and ill-defined. The Municipal Acts and by-laws are so inconsistent and cumbrous as to render the work of improvement of insanitary areas extremely difficult.

The creation of improvement trusts in several cities in India has to some extent paved the way for a more serious and enlightened policy, but up-to-now, the work of improvement trusts has been tentative.

No attempt at town-planning in the real sense of the word has been undertaken, and with the exception of the initial efforts of the City of Bombay Improvement Trust very little has been done in the absence of town-planning schemes to get at the bottom of the real evil, namely, the housing of the working classes and improvement of insanitary areas, because there is no financial return.

Much, however, has been done in the widening of streets, and Bombay of to-day is a vastly different place to what it was in 1898; but if real progress is to be made in the direction of town-planning in cities in India, what is wanted is an Act and by-laws on the line of the Housing and Town Planning Act of England, 1909, and a local authority to carry them out under a governing body.

Part I of this Act deals with the housing of the working classes.

Part II deals with town-planning.

I quote here extracts from the laws obtaining in England dealing with this subject taken from the Municipal year book.

Extracts.

Housing legislation in England began with Lord Shaftsbury's two Acts passed in 1851, and was continued with Torren's Acts, 1866 and 1868, and Cross's Acts, 1875, 1879 and 1882, and by various Local Improvement Acts. The Metropolitan Board of Works spent £1,325,415 on 16 schemes, and sold or let the sites at nominal prices to various companies for building working class dwellings to house the persons displaced. The companies thus subsidised erected 7,026 dwellings, containing 14,093 rooms.

Other districts cleared unhealthly areas at a cost as follows, after recoupment for land resold:—Birmingham, 95 acres for £550,000; Glasgow, 88 acres for £600,000; Liverpool, £500,000; Greenock, £ 200,000; and Wolverhampton, £267,862; while the annual charge on the rates at Swansea has been over £3,000. In the majority of these cases some of the persons displaced were re-housed in dwellings erected by the municipal authorities. Owing to the expensive working of these Acts, however, they were not used much after 1882, and it became necessary to consolidate and amend them by the Housing of the Working Classes Act, 1890. This Act has itself been modified by subsequent Acts, notably the Acts of 1900 and 1903, and the Housing and Town Planning Act, 1909.

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Powers of local authorities with respect to the housing of the working classes may be to be contained in—

(1) The Public Health Act, 1875 (Sanitary clauses), together with the amending or esponding measures, the Public Health Acts (Amendment) Acts, 1890 and 1907, the lic Health (London) Act, 1891, and the Public Health (Scotland) Act, 1897; and by-laws le under the provisions of the same;

(2) The Housing of the Working Classes Act, 1890, with Amending Acts of 1893, 1894, 6, 1900, 1903 and 1909;

(3) The Small Dwellings Acquisition Act, 1899;

(4) The Municipal Corporation Act, 1882 (Section III), and the Working Classes ellings Act, 1890;

(5) The Labourers' (Ireland) Acts, 1885–1906;

(6) The Standing Orders of Parliament for Local Improvement and Public Companies' s.

far as the provision of houses is concerned, the most important of these are the Housing he Working Classes Acts, 1890, 1903, and the Housing and Town Planning Act, 1909.

The principal Act (1890) is divided into seven parts and the following summary of sing powers has been arranged under the three most important of these divisions, viz., t I, the clearance of large slum areas; Part II, the clearance of small slum areas and the sing and demolition of unhealthy houses or obstructive buildings; and Part III, which ls with the provision of new dwellings by or through the action of local authorities.

The Amending Act of 1900 modified Part III of the principal Act by empowering ncils to buy land outside their districts (section 1) and to lease any land bought within or side their districts to persons willing to build cottages (section 5), as well as for the lding of cottages by the local authority. It also provided for the raising of money for t III, schemes by metropolitan boroughs (section 3), and for simplifying accounts kept ler the various parts of the principal Act (section 4). Other provisions were also made, have since been repealed.

The Housing and Town Planning Act, 1909, modifies a number of provisions in previous s as respects the keeping of houses in repair (sections 14 and 15), the closing and demoli- 1 of unhealthy dwellings (sections 17 and 18), the clearance of slum areas (sections 23/29), appointment of County Medical Officers of Health (sections 67 and 68), and the vision of new dwellings for the working classes. It requires County Councils to establish blic Health and Housing Committees (section 71), and it gives them a number of default vers as regards District Councils and the principal Act (sections 10 and 12), while also ing concurrent powers, under Part III, in rural districts (section 13).

Duty of local authority as to closing of dwelling house unfit for human habitation.

(1) It shall be the duty of every local authority within the meaning of Part II of the ncipal Act to cause to be made from time to time inspection of their district, with a view ascertain whether any dwelling-house therein is in a state so dangerous or injurious to lth as to be unfit for human habitation, and for that purpose it shall be the duty of the al authority and of every officer of the local authority to comply with such regulations and keep such records as may be prescribed by the Board.

(2) If on the representation of the Medical Officer of Health, or of any other officer of authority or other information given, any dwelling house appears to them to be in such a te, it shall be their duty to make an order prohibiting the use of the dwelling house for man habitation (in this Act referred to as a closing order) until in the judgment of the al authority the dwelling house is rendered fit for that purpose.

(3) Notice of a closing order shall be forthwith served on every owner of the dwelling use in respect of which it is made, and any owner aggrieved by the order may appeal to the cal Government Board by giving notice of appeal to the Board within fourteen days after e order is served upon him.

(4) Where a closing order has become operative, the local authority shall serve notice the order on every occupying tenant of the dwelling house in respect of which the order is ade, and within such period as is specified in the notice, not being less than fourteen days ter the service of the notice, the order shall be obeyed by him, and he and his family shall ase to inhabit the dwelling house and in default he shall be liable on summary conviction to ordered to quit the dwelling house within such time as may be specified in the order.

(5) Unless the dwelling house has been made unfit for habitation by the wilful act or fault of the tenant or of any person for whom as between himself and the owner or landlord is responsible, the local authority may make to every such tenant such reasonable allowance 1 account of his expense in removing as may be determined by the local authority with the nsent of the owner of the dwelling house, or if the owner of the dwelling house fails to nsent to the sum determined by the local authority, as may be fixed by a court of summary risdiction, and the amount of the said allowance shall be recoverable by the local authority om the owner of the dwelling house as a civil debt in manner provided by the Summary risdiction Acts.

(6) The local authority shall determine any closing order made by them if they are satisfied that the dwelling-house in respect of which the order has been made has been rendered fit for human habitation.

If on the application of any owner of a dwelling-house, the local authority refuse to determine a closing order, the owner may appeal to the Local Government Board by giving notice of appeal to the Board within fourteen days after the application is refused.

(7) A room habitually used as a sleeping place, the surface of the floor of which is more than three feet below the surface of the part of the street adjoining or nearest to the room, shall for the purposes of this section be deemed to be a dwelling-house so dangerous or injurious to health as to be unfit for human habitation, if the room either—

(a) is not on an average at least seven feet in height from the floor to ceiling; or

(b) does not comply with such regulations as the local authority with the consent of the Local Government Board may prescribe for securing the proper ventilation and lighting of such rooms, and the protection thereof, against dampness, effluvia, or exhalation: provided that if the local authority, after being required to do so by the Local Government Board, fail to make such regulations, or such regulations as the Board approve, the Board may themselves make them, and the regulations so made shall have effect as if they had been made by the local authority with the consent of the Board.

Provided that a closing order made in respect of a room to which this sub-section applies shall not prevent the room being used for purposes other than those of a sleeping place, and that if the occupier of the room, after notice of an order has been served upon him, fails to comply with the order, an order to comply therewith may, on summary conviction, be made against him.

Order for demolition.—(1) Where a closing order in respect of any dwelling-house has remained operative for a period of three months, the local authority shall take into consideration the question of the demolition of the dwelling-house, and shall give every owner of the dwelling-house notice of the time (being some time not less than one month after the service of the notice) and place at which the question will be considered, and any owner of the dwelling-house shall be entitled to be heard when the question is so taken into consideration.

(2) If upon any such consideration the local authority are of opinion that the dwelling-house has not been rendered fit for human habitation, and that the necessary steps are not being taken with all due diligence to render it, so fit, or that the continuance of any building being or being part of the dwelling-house is a nuisance or dangerous or injurious to the health of the public or of the inhabitants of the neighbouring dwelling-houses, they shall order the demolition of the building.

(3) If any owner undertakes to execute forthwith the works necessary to render the dwelling-house fit for human habitation, and the local authority consider that it can be so rendered fit for human habitation, the local authority may, if they think fit, postpone the operation of the order for such time not exceeding six months as they think sufficient for the purpose of giving the owner an opportunity of executing the necessary works.

(4) Notice of an order for the demolition of a building shall be forthwith served on every owner of the building in respect of which it is made, and any owner aggrieved by the order may appeal to the Local Government Board by giving notice of appeal to the Board within twenty-one days after the order is served upon him.

Part I provides for the clearing of large unhealthy areas (in urban districts only) (section 8), and the execution of an improvement scheme for the district dealt with.

The authorities empowered to take action under it are the London County Council and all urban district councils or town councils (schedule 1).

It is the duty of the Medical Officer of Health when he sees proper cause, or when two or more justices or twelve or more ratepayers in his district complain of any unhealthy area therein, to inspect such area, and make an official report on it in writing to the local authority (sections 5 and 79).

If the Medical Officer of Health represents the area as not unhealthy, twelve or more ratepayers may appeal to the Local Government Board, who, upon security for costs being given, must appoint a legally qualified medical practitioner to report on such area, and the local authority must act on this report (sections 8 and 16).

Improvement scheme.—Where an area is thus officially represented to be unhealthy, the local authority, if possessed of sufficient resources, must make an improvement scheme. The improvement scheme must be accompanied by maps, particulars and estimates. It need not be confined to the exact limits of the unhealthy area, but may include lands which the local authority considers necessary to the efficiency of the scheme, or for the purpose of providing accommodation for displaced members of the working classes (sections 6 and 11). In default of the local authority making a scheme it may be made by the Local Government Board and enforced by mandamus.

It must be advertised, and the Local Government Board or other confirming authority must hold a local inquiry, and may then make a provisional order confirming the scheme (sections 7 and 8).

The local authority may pull down the buildings, clear out the area and make or widen any necessary streets upon the lands dealt with, after compensating the owners and others concerned (section 12).

Terms of compensation.—Provision is made for the assessment of compensation by the purchase clause in section 21, which enacts :—

(1) That compensation shall be based upon the fair market value at the time of valuation without any additional allowance in respect of compulsory purchase.

(2) In forming the estimate, due regard is to be had to the nature and condition of the property, and the probable duration of the buildings in their existing state ;

(3) Deductions are also to be made for existing nuisances—

(*a*) For an enhanced value by being used for illegal purposes or owing to overcrowding ;

(*b*) For the bad state of repair in which the premises are found ;

(*c*) The property not being reasonably capable of being made fit for habitation.

The arbitrator may be appointed by the Local Government Board, if so requested by the local authority.

The expenses and income of a scheme under this part of the Act must be carried to a "dwelling house improvement fund," and the necessary loans may be raised in the ordinary manner (sections 24 and 25).

The Act of 1909 in sections 22 to 27 modifies this part of the Principal Act, as regards official representations; contents of schemes; loans from the Public Works Loan Commissioners; modification, abandonment of, or addition to a scheme; the tendering of evidence to secure reduced compensation; the extinction or modification of rights and easements; the application of money borrowed for the dwelling house improvement fund; and by repealing sections 9, 17, 18, 19, 27 and 28 varies the procedure as to local inquiries and the service and publication of notices and advertisements.

Re-housing persons displaced.—Accommodation must be provided as follows :—

(*a*) In London, either for the whole or not less than half of the population displaced, to the satisfaction of the Home Secretary, unless it can be shown that within the immediate vicinity the required accommodation has been or is to be otherwise provided ;

(*b*) in any other urban district such accommodation (if any) as determined by the Local Government Board.

It will, of course, be noted that the whole question of re-housing under other Acts is regulated by the schedule to the Housing of the Working Classes Act, 1903, which contemplates the provision of new dwellings, in some cases before demolishing the old ones, and requires all houses provided under the Act to be used for working class dwellings at least twenty-five years. By the schedule to this Act—

(*a*) If "thirty or more persons" are to be displaced under Parliamentary powers, the promoters of the undertaking must first obtain formal approval of a scheme for re-housing.

(*b*) In fixing the number to be re-housed, persons of the working classes displaced during the previous five years are to be considered.

(*c*) The conditions under which and the persons for whom, and by whom re-housing of displaced persons must be carried out are more clearly and stringently defined (Act of 1903).

Part II has been considerably modified by the repeal of sections 32 and 33 and part of 29 and 39 (5), (6), (8), (9), 47 (3) dealing with closing orders, demolition orders and obstructive buildings and also by modifications of sections 29, 36, 37 (1), 38, 46, 49 and 51, dealing with the definition of dwelling house; making of charging orders; compensation for obstructive buildings ; confirmation of reconstruction scheme; enlargement of matters that may be provided for under part II to the same extent as under part I; payments by County and Borough Councils towards Part II. Schemes; enlargement of time by local Magistrates; service of notices and description of owner and the inspection of premises by authorized persons.

As amended it provides for—

(1) The inspection of every sanitary district from time to time, with a view to ascertain whether there are any houses unfit for human habitation [section 17 (1), Act of 1909].

(2) The keeping of such records of inspection as the Local Government Board may prescribe [section 17 (1), Act of 1909].

(3) The closing by order of the local authority of any dwelling-house, represented by any officer of the authority as being unfit for human habitations [section 17 (2), Act of 1909]. The order to become operative subject to an appeal to the Local Government Board, but without recourse to the Courts of Law.

(4) The demolition by local authority of any dwelling-house where a closing order has remained operative over three months (section 18, Act of 1909).

(5) The enforcement of local authorities of a provision that houses let under certain rentals shall be kept in all respects reasonably fit for habitation (section 75 and sections 14, 15, Act of 1909).

(6) Removal of obstructive buildings (section 38 and section 28 (1), (2) of the Act of 1909).

(7) The re-construction of small unhealthy areas (sections 30 and 40 with sections 23, 24 and 33 of the Act of 1909).

It applies to all urban and rural sanitary authorities, but those in London, and rural districts must communicate all steps taken to the County Council (section 45 and Schedule 1).

Obstructive buildings.—The Medical Officer of Health or any four rate-payers may inform the local authority of any building:—

(*a*) so dangerous or injurious to health as to be unfit for human habitation.
(*b*) which stops ventilation or otherwise conduces to make other buildings injurious to health.
(*c*) which prevents proper measures from being carried into effect for remedying any nuisance injurious to health (sections 31, 38 and 39).

Small improvement scheme.—A scheme on the lines indicated in Part I, may be passed by the local authority for re-constructing any area, containing buildings, such as those above-mentioned and must make the required provision for the accommodation of persons of the working classes displaced by the scheme, and allowance may be made to the tenants for reasonable expenses of removal (sections 39 and 40). The Local Government Board will decide as to which part of the Act proceedings should be taken under.

How to get more workmen's dwellings.—This is the most important part of the Act, because it enables local authorities to carry out a scheme to build houses for the working classes. There is no provision limiting the power of the local authority; no certificate or other formal proof of deficient house accommodation is requisite; no insanitary property need be closed or demolished. The local authority can decide to build at any time and for any reason which may seem good to it, provided, as in all other municipal work that the Local Government Board will sanction any necessary loans.

How to get land.—Land can be purchased compulsorily if necessary as provided in section 2 of the Act of 1909 and the Lands Clauses Consolidation Act, 1845, and no lease, settlement, entail or other private arrangement can debar a local authority from acquiring it.

By section 7 of the Housing Act of 1900, land can be acquired for the purposes of this Act either inside or outside the district. The price is to be the "fair market value," with no allowance for compulsory purchase (Schedule 1 (3), Act of 1909). The value has to be determined in case of dispute by a single arbitrator appointed by the Local Government Board.

What may be done with the land.—Land acquired under Part III may be either—

(1) Leased to companies or builders or working men for the erection thereon of workmen's dwellings (section 5, Act of 1900); or,

(2) The Council may itself undertake and carry out—

(*a*) the erection of lodging houses, block dwellings, tenement houses, cottages (sections 53 and 59), and shops for the benefit of the tenants (section II, Act of 1903).
(*b*) the purchase and improvement or re-construction of existing lodging houses, dwellings, or cottages (section 58).
(*c*) the purchase or exchange of land for the purpose of encouraging such construction, improvement. or re-construction (sections 56, 57 and 60), and the laying out or construction of public streets or roads (section 6, Act of 1909).
(*d*) the provision of a garden, not more than an acre in extent (section 53 and section 50, Act of 1909).
(*e*) fitting up, furnishing, and supplying the dwellings with all requisite fittings, furniture and conveniences (section 59).
(*f*) making any necessary by-laws and regulations (sections 61 and 62).
(*g*) selling the houses if desirable and necessary after a period of seven years (section 64).

How to get money for land and buildings under Part III.—The conditions as to loans obtained by local authorities are as follows:—

(1) The London County Council may, with the assent of the Treasury, create consolidated stock, and provide for repayment within 80 years;

(2) London Borough Councils may, if the County Council think fit, borrow from the County Council or from the Public Works Loans Commissioners;

(3) Urban district councils and town councils may either borrow from the Public Works Loans Commissioners or issue stock or borrow on security of the rates, subject to the following conditions :—

(1) The consent of the Local Government Board must be obtained.

(2) The period of re-payment of the loan must not exceed eighty years.

(3) Money so borrowed is no longer to be reckoned as part of the debt of the local authority for the purposes of the limitation on borrowing under section 234 (2) (3) of the Public Health Act, 1875.

Under the Act of 1909, Public Works Loan Commissioners may lend up to eighty years, and it is provided that the interest on loans for long periods shall not be greater than for short periods (section 3).

County Councils may lend to societies of public utility (section 72, Act of 1909) who may also borrow direct from the Public Works Loan Commissioners (section 4, Act of 1909).

Housing of the working Classes in Indian cities.

Take Bombay.—There are some 37,930 buildings in Bombay ; 53 of these buildings contain 400 persons.

A dwelling-house means—any building used wholly or principally for human habitation, and includes any yard, garden, out-house, etc., and the site of the dwelling-house so defined and includes schools, factories and other buildings where persons are employed.

For census purposes— a house is a building under one undivided roof or having two or more roofs connected *inter se* by subsidiary roofs.

A " chawl " means a building so constructed as to be suitable for letting in separate tenements, each consisting of a single room or of two rooms but not of more than two rooms.

There are 166,337 occupied one-room tenements, giving an average at 4·47 persons per room, and no less than 76 per cent. of the population live in one-room tenement.

Working classes in Bombay.—Seventy-six per cent. of the people of Bombay come within the category of working classes, *i.e.*, about 760,000.

Many of the rooms are occupied by more than one family.

The rent of these rooms is from Rs. 3 to Rs. 5 per mensem, the average monthly wages of this class is Rs. 20 per mensem.

The working classes in western cities live under almost identical conditions. Their habits, customs and mode of living are the same. The only difference being the variation in the cost of living and frugal tendency of some countries and the rate of wages. The working classes in large cities like Bombay are made up of different divisions of the backward classes. Each division is governed by its own customs, habits and caste prejudices. Their mode of living is also not the same, as they live under different conditions of life. In consequence of these differences, there is the obvious necessity of housing each section under conditions, suitable and favourable to each particular division. For housing purposes it is therefore necessary to divide the working class population of a large Indian city like Bombay into divisions, governed by their own customs and habits. Fully over three-fourths of the population of this City is comprised of the working classes, the majority being Hindus, as compared with the Muhammadans.

The Indian is well known to be gregarious in his habits—he follows the leader. Caste and customs have separated these divisions from time immemorial. There is no alternative therefore in solving the housing problem ; the existing basis must be considered and each division provided with housing accommodation on sanitary lines and within their means. For practical purposes the divisions may be described as follows :—

(1) *Hindus.*—These chiefly consisting of the depressed and backward classes *i.e.*, (1) Mahars, (2) Chamars, (3) Mhangs, (4) Dhers. These come into the city in search of labour and subsistence from villages in the Konkan and Deccan. The last sub-division (Dhers) includes those coming from Kathiawar. This division

supplies labour to (*a*) Docks — as dock labourers, coal fillers, etc. (*b*) Municipality and Port Trust Railway for scavengering, conservancy, etc., (*c*) in other miscellaneous works, as laying down drains, sewers, filling up excavation, etc.

The housing of these people has so far been found a most difficult task, as no other community will live in close proximity to them, because of their thieving propensities, immoral proclivities and filthy habits. The conditions under which the individuals of this division live, requires a little description. They live all huddled together in the open, or mat-huts or chawls, set apart for these people only. Families live promiscuously. Their personal habits are very filthy and they seem to flourish in squalor. The individual cost for maintenance is infinitesmal. They live on almost anything. Nothing is prohibited to them by religion or caste. Caste as such does not exist with them. Everything is welcome, from dead meat to leavings of Eating houses, Mahajan-wadies and hotels. In chawls they live in single tenement rooms, generally dark, ill-ventilated, damp and overcrowded. The average monthly wage of this division ranges from Rs. 8 to Rs. 12, the lower figure being that for female labour.

To obviate this difficulty in a degree, the municipality of this city was compelled to engage or build separate chawls for their housing. With this view several chawls were built in Valpakhady and Kamathipura and the Halalkhores, most of whom belong to the Dher sub-division housed in them. The result has been so far very encouraging, it is therefore intended to house all the Halalkhores together forming a kind of a separate invention for them at Valpakhady. On account of the constant supervision exercised in these chawls and the repeated hygienic homilies given, these people have now begun to appreciate the advantages of hygiene and a very considerable improvement can be observed. Their rooms are kept in a more orderly fashion and their personal habits have considerably improved. Provision for the housing of the other sub-divisions under municipal control is being made. Chawls are in the course of construction, wherein Mahar and other "Begaries," scavengers, will be housed. At present they will be served with single tenement rooms of sufficient dimensions; because of their scanty wages and increased dearness in living in Bombay and because other communities will not have them in their immediate vicinity. As a natural consequence there is a great overcrowding. If the other great employers of this class followed the example and made provision for housing them, overcrowding would be reduced to a minimum and sanitary rules enforced, with consequent diminished incidence of disease and reduced mortality. So far, these "labour class dwellings" are run with a certain monetary loss, as only a certain deduction is made for rent from the wages of the tenants, but this loss is compensated, in fact, with actual profit to the employers by having more healthy men at work, putting in a greater number of healthy working days.

The Marathas form the second great division of the working classes; they supply domestic servants, mill-hands, coolies, weight-carriers in grain godowns, in the Port Trust and docks, cotton-greens, these are also engaged all in petty businesses as vegetable dealers, fruiterers, grocers and bullock-cart drivers, masons. Their average monthly wages vary from Rs. 12 to Rs. 25, depending upon the nature and quality of work. They come from the Deccan or Konkan. The Deccani Marathas are a very hardy and sturdy lot, not afraid of any hard work and always doing it cheerfully. The Konkani Maratha is of a smaller and a weaker built and generally works in mills or in domestic service. The Maratha female is a helpful mate, contributing between Rs. 10 to Rs. 12 or a little over towards the household expenses. The actual cost of living to a Maratha is an expensive item. The cost of living for each working individual is about Rs. 9, having only bare necessities. The Marathas are very conservative in their habits. They eat only what is cooked at home or by their caste brothers. They generally live in chawls in single tenement rooms, paying on the average between Rs. 3 and Rs. 6, depending on the size and its sufficiency for accommodation of a family which may consist of 8 to 10 members. The increase in rents with the recent rise in valuation of landed property tells heavily on their meagre income. The kind of labour they give in return for wages is of a superior kind and more thorough as compared to the first division. These people are also of cleanlier habits, both personal and domestic and as a rule are not lazy or indolent. The housing accommodation for this ever-increasing class is insufficient and daily is becoming more keenly felt; the landlord fully realizing this,

allows overcrowding on increased rents. The rents which a decade ago were Rs. 1–4 per room of 10′ × 10′ × 10′ have risen quadruple and in equal ratio the higher rents. From experience it has been found that the Marathas have improved in their domestic and personal hygiene considerably and the efforts of the Health Department and Sanitary Association in this direction have not been in vain. They have appreciated the supervision and hygienic conversations, given them in their chawls with noticeable improvements in their persons and in their rooms. This ever-increasing population requires proper and adequate housing as they form the backbone of commerce, industries and trades. Without them the city commercially would be at a standstill and suffer severely. No other community can supplant this labour. It is therefore imperative that proper sanitary and cheap housing accommodation be provided for them. An average of Rs. 3 or Rs. 4 per room of 12′ × 10′ × 10′ would go a long way to promote their interests and well-being. All things considered, the Maratha is a very law-abiding individual, with healthy tendencies. The Maratha also supplies a certain amount of skilled labour and a large proportion goes to fill up the ranks of the native police constabulary. The latter are provided by Government housing accommodation in police chawls, a step in the right direction and an example to be followed. As housing accommodation is needed, it should be provided by the large employers of labour on sanitary lines, which would yield a sufficient and reasonable profit.

The third great division of the working classes comprises the Muhammadan element. This division may be sub-divided into groups—those earning between Rs. 10 and Rs. 20, and those earning between Rs. 20 and Rs. 50. The latter group will be separately described. The first group comprises Muhammadans, coming chiefly from the Deccan and Konkan and to a lesser degree from Kathiawar. The Konkanis supply domestic servants, office puttawalas, boatmen, lascars and policemen, when not with their families they club together in rooms; the number thus accommodated varies from 20 to 50 persons according to the size of the rooms. If accompanied with a family, a single tenement room is engaged—the majority of them dark, damp and ill-ventilated and scarcely sufficient for the members of the family, therefore generally overcrowded. The rent varies from Rs. 3–8–0 to Rs. 4–8–0. Their mode of living is very poor; cheap and dried fish is the chief element in their food-stuffs. The Konkani Muhammadan is indolent and lazy in his habits as compared to his Deccani confrere. The latter is more aspiring and ambitious. Hence he apprentices himself to some trade or business and most of these earn a higher wage, ranging from Rs. 20 to Rs. 50. By occupation they are generally fitters, plumbers, joiners, carpenters, turners and factory hands. They generally house themselves in the double tenement rooms paying a rent of Rs. 8 to Rs. 10. The double tenement rooms consist of one living room 10′ × 10′ × 10′ and one smaller, the cook room. The latter provides also a small "nahani" or bathing place. The double tenement, as at present obtains, does not provide healthy accommodation as the rooms are dark and ill-ventilated and most of them abutting on common house gullies. Those abutting on the street may be called superior in comparison, but their rents are higher from Rs. 10 to Rs. 15. At present, advantage is taken by these people of the better housing accommodation provided in the Improvement Trust chawls, where they happen to be in close proximity to Muhammadan localities. They have learnt to appreciate this improved accommodation and the rooms are readily taken up by them. Among the working classes should also be classified clerks and artizans, bricklayers and Victoria drivers, belonging to all denominations, whose monthly wages range between Rs. 25 and Rs. 60. These generally occupy double tenement rooms, the rent of which averages between Rs. 10 to Rs. 15. The actual cost of living per each adult individual is about Rs. 15, having only the bare necessities of life. The size of double tenement rooms is 10′ × 10′ × 10′ and the second which serves as cook-room, smaller in dimensions. With the exception of those abutting on streets, the rest have insufficient light, and the ventilation is vitiated by the windows abutting on common house gullies in which basket privies abound. The house-rent of the rooms occupied by this class is by about 60 per cent. higher as compared to a decade ago. This class—specially clerks—are generally weakly built and of insufficient energy; after a continued work of about a year they generally suffer or become apathetic and slow and slack at work. They cannot save anything. For this class of people flats with double tenement rooms should be provided whose rents must not be over Rs. 10 and rooms having plenty of light and ventilation.

The poorer classes of Christians and Beni Israelites club together in rooms and live under identical conditions as live the Konkani Muhammadans.

Working classes in large cities in India live an artificial life in houses and under conditions to which they are unsuited, and which render any attempt at sanitation most difficult. It is the custom for several families to live, cook and sleep in the same room.

The large chawls in Bombay of 4, 5 or 6 floors separated from one another by narrow gullies and containing 200 and 400 rooms with a population of several hundreds of people living under the most insanitary conditions as to air, space and light and the presence of filth inside and around the rooms constitute in themselves a source of danger to health, and when the outbreak of plague or other infectious disease occurs, either by being introduced by human agency and animal agency, dust or filth, the disease will spread rapidly amongst the inmates who are huddled together in a very limited area in contravention of all sanitary principles, and when once the disease gets its foothold it is difficult to displace.

The occupation of chawls of many floors and rooms is opposed to the habits of the peoples of an eastern city. The people cannot be supervised or regulated. Every room in a house is occupied generally by more than one family. All the refuse and water is thrown out into the streets and gullies; intercommunication between families when infectious disease occurs is impossible to control; isolation of a case of infectious disease is impossible.

Insanitary conditions.—The relation between the overcrowding and insanitary condition and a high mortality has been dealt with by all sanitarians, from time to time. In cities in India a high mortality follows closely insanitary surroundings, absence of domestic personal hygiene, overcrowding insanitary areas, want of ventilation and light, and the presence of filth,—in fact, the incidence of disease is directly related to the insanitary domestic surroundings;—the incidence varying with the habits and customs of the people with regard to their food, personal cleanliness, domestic habits, washing, bathing, cleaning of rooms, clothes and persons, habits of living, sleeping, accumulation of material and filth, harbouring vermin, condition of floors of wall and ceilings of houses and prejudice against the measures for improvement or any attempt to remove what is considered the cause of the spread of the disease.

Insanitary surroundings may then be termed anything or any condition which tends to impair health, and one of the great factors is poverty and ignorance. Of the total influence which these surroundings exert on the health of the people exposed to them no exact statement can however be given. That they produce certain disease and a certain amount of disablement is undeniable, but it is only so far as the varying incidence of such sickness is ascertained and the disease kills that the effect can be represented in numbers.

Insanitary surroundings may be divided into external and internal :—

(1) External conditions are sanitary defects in areas, dense aggregation of houses, congested areas, and as a result inadequate open spaces about dwellings, insufficient light and air.

(2) Dampness of soil.

(3) Want of drainage or defective drainage leading to pollution of soil.

(4) Defective means for removal of excreta and polluted matter, street sweepings, trade and domestic refuse.

(5) Defective sanitary laws and their difficulty of their application.

(6) Habits and customs of people, religious and other prejudices with regard to exposure of infected persons and things.

Internal conditions with regard to overcrowding in houses and rooms.
Ventilation of rooms.
Dampness of rooms.
Lighting of rooms.
Character of the floor and wall.
Conditions as to cleanliness.
Method of collecting rubbish in rooms.

Conditions harbouring of vermin on bodies and clothes.
,, of clothing of persons.
,, of washing and bathing.
,, of occupation and habit.
,, of skin disease due to climate and clothes, and habits inducing facilities of contracting plague.

Conditions of custom in the preparation of food and their foodstuff.

Such insanitary conditions are, as is well-known, powerful predisposing causes in the production of phthisis, pulmonary diseases other than phthisis, diarrhœal diseases and fevers and epidemic diseases generally, and a reference to any statistical table in the report of various health departments all over the world will show that in areas with such insanitary surroundings the sickness and death-rates are considerably above the average and when those areas have been improved by sanitation, the mortality and sickness, both general and zymotic, have much improved. As an illustration of this in Bombay, I take three sections of the city where the sickness and mortality have always been high.

All these sections vary somewhat in character with regard to class of persons and occupation, but they all have one common feature,—overcrowding and insanitary surroundings, habits, customs and prejudices against what is known as practical sanitation or measures which interfere with the habits and customs.

A description of a few of these areas will be sufficient to show that they come within the category of insanitary surroundings, while a reference to the diagram will show what relation overcrowding has in each particular instance.

Dhobi talao.—There is considerable density of houses in this area. The houses are in most cases attached to one another and back to back, so that there is a long range of gullies. In many instances the drainage passes through the house. The houses are mostly insanitary owing to imperfect ventilation. A great number of the houses are three-storeyed and give accommodation to a large number of people. There is considerable overcrowding. The ventilation being chiefly from the rear and front, and in other cases imperfect, the air in the house is highly charged with organic matter. There is further vitiation of the air from the products of incomplete combustion from the various fire-places. These houses with few exceptions cannot be so called, as each room forms a separate tenement. With a few exceptions the privies are on the basket system, and the large amount of human excreta accumulation in a day further adds to the deterioration of public health. The locality itself is low lying and the sub-soil water is also high as is evidenced by the high water mark in most of the wells. This causes dampness of the houses. The fact of a large number of high houses with small narrow lanes further adds to the insanitary condition of the locality from blockage of a free circulation of air. The general insanitary condition is enhanced by a very large wastage of water, which further adds to dampness of the soil. This area has a very bad plague history, and a large number of plague cases occur every year since the advent of the epidemic.

Population (1911).	Increase or Decrease since 1906.	Density per acre.	Birth rate (1911).	Infant mortality per 1,000 births registered (1911).
38,684	+ 2,090	388 0	21·79	308·4

Kamathipura.—The streets in Kamathipura are well arranged and fairly numerous, there being sixteen running across it from east to west and five from north to south. There is no uniformity about the houses and they vary much in shape and size. Most of them are sublet in separate tenements and are occupied by persons of the poorer classes. Many of these chawls are unfit for human habitation, either wholly or in part owing to radically defective construction.

Overcrowding is undoubtedly the chief cause of the unhealthiness of Kamathipura. This term is applied to two distinct conditions which, however, are invariably associated together. The one has reference to land upon which the houses are

situated in such close approximation that the provision of air, light and space is reduced to a quantity below the standard requirements of health, the other to houses in which the inhabitants exceed in number the accommodation. Both these conditions obtain in an exceptional degree in Kamathipura. The houses are built almost back to back, there being only a narrow passage between the row of houses in one street and that in the next. The depth of houses from front to back is excessive, and as usually the whole of the available space behind the street frontage is occupied by the building itself, the privies in many cases are not properly detached and the air of the dwelling is continually charged with the most noisome odours. There is rarely a gully at the sides of houses, and when one exists it is generally not more than two feet in width. As a result of this, the buildings as whole are deficient in light and ventilation, the centre rooms being often in absolute darkness and dependent for ventilation upon the passages within the houses. Speaking generally the gullies are open channels for carrying off sullage, but usually they are so imperfectly paved as not to be water-tight, and sometimes they are not laid with a proper fall towards the street drain. Many of them serve as passages for sweepers and are flanked on either side by a long row of privy shafts. In such cases the trap doors of the shafts abut immediately on the gully, and when the receptacles get full and overflow as they frequently do, the liquid filth is discharged on the surface of the gully. Refuse of all kinds is also thrown into the gullies by the people living in the adjoining houses. For these reasons the gullies, though repeatedly cleansed, are generally in a dirty and foul condition, and windows which overlook them have to be kept closed to exclude the smell. Such gullies are therefore of little use for purposes of ventilation. Moreover, owing to the structural defects pointed out above, liquid filth is not carried away, but stagnates in the gullies and the foundations of the houses and the soil around them are continually receiving what to all intents and purposes is the soakage of sewage. In this way the soil and subsoil are fouled and rendered damp and the level of the ground water is raised. Throughout Kamathipura this dampness of the soil can be observed and water is to be found within a few feet of the surface. As a result, dampness of ground floors is a noticeable feature in nearly all the houses, even in those with substantial plinths and paved or cemented floors.

Population (1911).	Increase or decrease since 1906.	Density per acre.	Birth-rate (1911)	Infant mortality per 1,000 births registered (1911).
36,751	+ 267	555·6	22·72	419·1

Second Nagpada.—The streets however are not well arranged as in Kamathipura, and there are only five streets of any size in the whole area and they run from north to south. There are no streets running from east to west, but only a few narrow cross lanes. Thus most of the houses receive the direct rays of the sun only for an hour or two in the day. The overcrowding within the dwelling and the dense aggregation of houses on area are greater than in Kamathipura, and the dampness of soil and sub-soil is also more marked. In other respects the description given of Kamathipura applies equally well to second Nagpada. It must be pointed out however that the inhabitants of second Nagpada are for the most part Muhammadans, and that it is the custom amongst them to seclude their women. The evil effects of overcrowding and want of ventilation are therefore greatly aggravated as might be expected. Phthisis and diseases of respiratory organs are more prevalent in this area than in any other part of Bombay.

Population (1911).	Increase or decrease since 1906.	Density per acre.	Birth-rate (1911).	Infant mortality per 1,000 births registered.
21,700	+ 316	638·2	25·29	402·5
The entire city.				
979,445	1,623	67·8	21·82	379·8

These conditions apply equally in a modified form to Calcutta and Madras, Delhi, Ahmedabad and any other large cities in India, but in Bombay only are large chawls found which are built to economise space, the land being more valuable.

Houses unfit for human habitation.—In dealing with insanitary dwellings the question of what constitutes a house unfit for human habitation is an extremely difficult one.

No scientific standard is or can be applicable.

Every sanitary circumstance has to be considered.

What would be considered unfit in Western Countries, would be fit in the East, where conditions of climate are so different.

According to the Public Health Act in England—any dwelling house that appears to be in a state dangerous or injurious to health is considered to be unfit for human habitation.

Under the Bombay Municipal Act, section 378—*Buildings unfit for human habitation are thus dealt with*—(1) If, for any reason it shall appear to the Commissioner that any building intended for or used as a dwelling is unfit for human habitation, he shall give to the owner or occupier of such building, notice in writing signifying his intention to prohibit the further use of the building for such purpose and calling upon the owner or occupier of such building to state in writing any objection thereto within thirty days after the receipt of such notice, and if no objection is raised by such owner or occupier within such period as aforesaid, or if any objection which is raised by such owner or occupier within such period appears to the Commissioner invalid or insufficient, he may, with the previous approval of the Standing Committee by an order in writing, prohibit the further use of such building as a dwelling:

Provided that, before, such approval is given, the owner or occupier of the building shall have the right of appearing before the Standing Committee in person or by Agent and of showing cause why such approval shall not be given.

(2) When any such prohibition as aforesaid has been made, the Commissioner shall cause notice of such prohibition to be affixed to and the letters "U.H.H." to be painted on, the door or some conspicuous part of such dwelling, and no owner or occupier of such building shall use or suffer the same to be used for human habitation until the Commissioner certifies in writing that the causes rendering it unfit for human habitation have been removed to his satisfaction.

In dealing with insanitary houses for the purpose of condemning them as "U.H.H." a systematic house inspection must be made.

House inspection has reference to—

(1) The arrangements for preventing the contamination of the water-supply.

(2) Closet arrangement.

(3) Drainage.

(4) The conditions of the dwelling house in regard to light. The free circulation of air, dampness and cleanliness.

(5) The paving, drainage and sanitary conditions of any yard, compound or out-house belonging to the dwelling house.

(6) The arrangements for the deposit of refuse.

(7) The existence of any room if it be so dangerous and injurious to health—a room habitually used as a sleeping place which is not on an average at least 7 feet in height from floor to ceiling or does not comply with such regulations as the local authority may prescribe for the proper lighting and ventilation of such rooms and the protection thereof against dangerous effluvia or exhalations.

(8) Any defect on other matters which may tend to render the dwelling house dangerous or injurious to the health of an inhabitant.

Thus in reporting on a house as "U.H.H." many tenements—single rooms—may be fit, while others are unfit for all or any of these reasons given above.

Mr. Orr, Chairman of the Bombay City Improvement Trust, defines a room as "U.H.H."—when it fails to reach a prescribed standard of light and ventilation.

But much more than this is required.

By-laws regarding the door and window space should be laid down and insisted on.

So also the sanitary arrangements,—stair-case, passage, roof and ceiling, cubic space per head and the sanitary conveniences.

In Bombay especially is the question of light and air—more important because of the height of the tenement houses and of buildings occupied in many instances by 500 to 1,000 persons.

The native working men and women for domestic reasons object to light and air and it is common to see even the model improvement trust chawls with rags or bags stretched across the windows. They do not seem to require light nor air and we must not consider everything has been done when we have caused every house and room to be with a ventilator rebuilt up to 63½ degrees scale standard.

The only education in sanitary matters these people understand are laws and by-laws and this is the form education should take. The millenium will have arrived when they voluntarily carry out sanitary measures.

I suppose there are few cities, where more experiments have been made in the class of buildings for the poorer people. All large employers have tried their hands at it and huge blocks of buildings have been erected by the Improvement Trust, Port Trust, Railways, Mills, etc.

What the native workman is satisfied with—is a room 10 × 10 × 10—a small verandah, a nahani and a small room for cooking where to stack his wood, cowdung cakes, pots, and pans—and perhaps fowls and goats a loft to store wood or lodge boxes, rags or logs; more often than not the cooking is done in the living room and the smoke escapes into the passages or out of the window.

The floor is used for sleeping where circumstances do not permit of a charpoy; the baby is slung in a cot or lies on the floor—the floor is cowdunged regularly and also the walls.

The nahanies are used by the children and for washing and stacking firewood, the refuse is thrown out of the window. Water is stored in an earthen vessel in the nahani and the pots and vessels cleaned there, or taken out to the street or nearest bathing place.

The privy accommodation may be a W.C. or a privy basket, situated at the end of the passage adjoining the common bathing room which is crowded with men and women fighting for water and washing vessels and their clothes.

In the majority of these dwellings it is impossible to see in any of the rooms or passages in the day time or to get through them without a lamp.

I will not dwell longer on the conditions as they are, but I will try and deal with what they should be.

Type of working class dwellings required.—The working man in large cities in India could be suitably housed in a room 10 × 10 × 10—for family, man, wife and two children as the maximum number of inhabitants.

The room will be a tenement of a building commonly known as chawl in Bombay, should have a window space of one-seventh floor area and a small verandah and a nahani and a bathing place and cooking place with an exit for smoke.

The room should be so arranged that at least one side should abut on an open space 20 feet from any other building—well lighted and ventilated, and if the rooms are in two rows opening into passage 10 feet wide on the other side, and provided with a ventilator of at least 3 square feet in area near the top of each of the two walls of such rooms. Such ventilators to be opposite each other.

The walls should be of brick, cement, concrete or other impervious material; the ceiling and the floor of tiles or cement and stone with a smooth polished surface with rounded corners—a window carried up to the ceiling and made to open, top and bottom, with half doors.

The foundation should be of concrete with a plinth 2·3 feet high.

The ideal building should be rat-proof, but I fear, this ideal cannot be lived up to, in a large city in India.

The closet arrangements must be determined by the water-supply and drainage system, but in all cities where such a supply is sufficient for the purpose, I strongly advocate the W.C. system.

In cities, where the W.C. system is provided, proper accommodation should be given for bathing and washing places in the compound or the space around the building.

One seat for twenty persons as a minimum.

If facing the rainy quarters the rooms should be provided with moveable shutters.

The building should be not more than one storey ground and first floor and not more than 20 rooms in each block.

The space around the building should be paved with asphalte or tarred

There should be open space enough for children to play. This can always be arranged in laying out blocks.

For eight months of the year in Bombay, Calcutta and Madras, many people sleep on the open paths, streets, marts and wadis.

Each block should be at least 20 feet apart and erected in such a position as to have breeze, light and air.

The erection of huge blocks of buildings is contrary to the habits of the people, prejudicial to health and difficult to control; as a question of expense and the initial cost of land, overcrowding of houses or areas is considered by some as a necessity.

From the point of view of the owners of the buildings this is financially sound: where the land has a value of Rs. 250 to Rs. 500 a square yard, it is easy to imagine that the owner or lessor wish to reap as much as he can.

But in India—even in Bombay where these houses have been allowed to be built—such excuse should not be tolerated.

The erection of such dwellings reduces the value of locality by overcrowding; they reduce the vitality of the inhabitants and foster disease—thereby reducing the number of workmen available and the amount of labour from each workman.

If certain parts of the city were set aside for erecting dwellings on sites which could be adapted and where land is cheaper—those parts of the city which are now covered with overcrowded insanitary areas would be vacated—a better class of buildings erected with better tenants and ultimately give better financial results.

For example.—The dock labourers should be housed near the docks—the mill hands near the mills—the general labourers in those parts of the town where land is cheaper. The clerks, etc., on sites easily accessible by tram or rail.

The most important section of the Town Planning or Housing Act is for improving old towns. In India it is that referring to the erection of workman dwellings and the policy of assisting migration from overcrowded insanitary areas in the expensive part of the city to other sites more remote, where fresh air, light and space can be had, where dwellings can be erected cheaply in one storied blocks capable of supervision.

The argument against this is that the people will not live away from their work.

This is proved to be incorrect in every city where it has been attempted.

The tendency of commercial enterprise is to erect factories, mills and large industries outside of the city proper, where the land is cheaper—rates and taxes less.

The policy to be followed.—This is the policy, I advocate. All municipalities should be empowered to acquire land and erect thereon workmen's dwellings either as a municipal concern or advance the money on certain conditions to responsible bodies or individuals. This will prove cheaper in the end than to acquire existing insanitary areas and to rebuild them.

The course of procedure should be as follows :—

Laws and bye-laws should be made under which the Medical Officer of Health through the local authority is bound to report on any insanitary dwellings which come to his notice.

A representation should be made to the governing body.

Action should be taken against the owner. Notice should be given stating the condition of the premises after due notice, the dwelling house should be declared as "U.H.H." or the area insanitary. Action for closing and demolition and rebuilding to be carried out according to laws and by-laws.

In many cities, thousands of such houses exist and such work is daily going on.

The local authority lays down a standard up to which the owner of the condemned house must conform.

It is impossible for him to comply with it owing to the existence of adjoining houses which just come within the municipal requirements—what can he do?

He cannot build a new house on a reduced area according to the prescribed standard which will bring him the same rent from the old dilapidated houses in which the poorer people lived—he therefore sells his own land or acquires the adjoining house and builds according to the standard laid down.

Moreover the local authority has decided that in this area certain restrictions are to be imposed as to light and air, height of houses, width of streets, open spaces, class of buildings, shops, factories, godowns under the Town Planning Act.

A house or houses condemned are therefore left tenantless—the tenants migrate to cheaper houses and the insanitary areas are gradually improved.

Simple hygienic rules for the guidance of municipalities in laying out sites and planning model houses for the poorer classes.

THE streets should be straight and intersect each other at right angles. The main streets should run in a direction parallel to the prevailing winds.

The main streets should in width be not less than 30 feet, the back streets should have a minimum width of 15 feet and the side lanes 6 feet between houses or 12 feet between blocks of houses.

All streets and lanes should have their surfaces higher in the centre and sloped to *pakka* drains of an approved section along the sides. Tree shade should be provided but only such trees should be planted as will give a maximum of shade with a minimum of obstruction to free circulation of air. No trees which have a heavy undergrowth should be allowed.

Large open spaces or squares should be provided at the intersection of the main roads.

All houses should be erected on a raised plinth at least 1 foot above the general ground level.

The foundations should consist of rammed *kankar*, or if the soil is good the walls may be built up from the bottom of the trenches

The walls up to plinth level should be of burnt brick laid in mud with the top course laid in lime mortar. The floors of the living rooms and verandah should be of burnt bricks laid in mud or preferably in lime mortar and if these can be laid over a 3-inch layer of concrete or rammed *kankar*, it will make the rooms less liable to be entered by rats.

The walls and roofs of the buildings above the plinth may be of cheap material, such as the people are accustomed to build for themselves. Each room should have a window opening directly to the outer air and equal in area to at least one-twelfth of the floor area. Each room should have a small opening at least 6 inches square in an outer wall near the roof for ventilation, if possible.

Each house whether single or one of a block should have at its rear an open space or courtyard equal in area to that of the plinth on which the house is built and raised 6 inches above the general surface of the ground. At least two-thirds of this area should be kept free from any erections.

The surface of the courtyard should be sloped to a drain running along one side and passing by an opening in the courtyard wall to the side drain in the street at the back of the house or block of houses. The courtyard should be paved, if possible.

The cooking and bathing platforms should be built in the courtyard and should have their floors raised 6 inches above the general surface of the yard. These floors should have a surface of brick well laid in lime mortar and should be sloped to a drain leading to the side drains in the street at the back of the house.

No private latrine should be permitted within the dwelling house or in the courtyard without the special permission of the municipal board. Where a latrine is sanctioned it should be built in the corner of the courtyard farthest away from the house and should have its floor laid in brick and lime mortar and raised 6 inches above the general surface of the courtyard. The latrine seat should be of glazed earthenware and be raised 6 inches higher than the latrine floor. The space for the nightsoil and urine receptacle or receptacles should have its floor and all four sides built of burnt bricks well laid in lime mortar. This space should have an opening on the back street or side lane so that the receptacles can be removed and replaced without the sweeper entering the courtyard. The latrine should be provided with a roof raised 1 foot above the walls to allow of free ventilation.

A site for excavation of earth for building purposes should be selected at least half a mile from the limits of the settlement, if a hollow is likely to result. No mud should be allowed to be taken from any other place. The formation of all tanks or hollows in the vicinity of the inhabited area likely to retain water should be rigidly avoided.

NAINI TAL:
The 9th July 1910.

W. G. WOOD,
Superintending Engineer,
Secy. to the Sany. Board, United Provinces.

PART II.

URBAN WATER-SUPPLIES.

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

Report on the monsoon condition of the Hooghly river and the results of experiments on silt removal.

BY

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Sanitary Commissioner, Bengal.

The condition of the large rivers in India has always been an interesting problem for such communities as rely on them as a source either of drinking or commercial water supply. The extraordinary change in the physical condition which is brought about by the rains is a point in which many are vitally interested. In this particular investigation our primary endeavour was to ascertain the capabilities of ordinary mechanical roughing filters in removing the silt from the Hooghly water during the monsoon.

Although many very interesting problems have been discovered and will be discussed, as they all bear on the wide subject of silt removal, our main endeavour was to study this problem from the point of view of a scheme, the conditions of which were that (1) preliminary settlement is out of the question, (2) that no cognisance will be taken of the bacteriological purity of the water, and (3) that absolute clearness is not contemplated as long as a very high percentage of the silt throughout the monsoon period can be removed. It will also be obvious that these conditions might apply to any township possessing large water works already in possession of ordinary sand filters who desired to ease the working of the filters by a preliminary roughing process. Consequently, the work has a fairly wide application.

The difficulties of the experiments are very considerable, as many and varying forces have to be reckoned with; thus, there is the amount of silt coming down the river which is caused by the monsoon rainfall; (2) the silt in the water which is due to the tides during the dry weather; and (3) there is the influence of the tide itself on the quantity of silt in suspension during the monsoon period. At any point situated beyond the reach of the tide, the study of the physical conditions of the river is a simple one, because there is only fluctuation in quantity of silt due to seasonal causes, but when this is complicated by a whole series of factors due to the tides, very carefully recorded facts are necessary, and much thought in interpreting these results. Obviously, the first stage in the understanding of the problem in hand is a careful study of the natural condition of the Hooghly in the neighbourhood of Calcutta.

In practically all of British India, and the tropics generally, there are two distinct periods in the year, *viz.*, the dry and the monsoon season. In Bengal the dry weather commences from the 15th of October and goes on till the 10th of June. During this period nothing more than occasional showers or storms are to be expected. In the period from the 10th of June to the 15th of October, a rainfall of about 80 to 90 inches is to be expected. It is pretty obvious therefore that when dealing with large rivers their physical conditions will vary considerably with the time of the year. It may be stated that the monsoon seldom makes itself felt on the Hooghly before the 1st of July—this year it was the 7th—and the river has practically never settled down to its dry weather condition till the 1st of November. The exact minute when the river becomes muddy from the burst of the monsoon is recorded at the various stations on the Hooghly, but the clearing process at the end of this season is a gradual one. Careful investigation, however, shows that although the water of the river appears to the eye to recover its clearness very slowly, as a matter of fact, the measured quantity of silt in the water falls off very rapidly after October the 15th, that is, the date of the cessation of the heavy monsoon rain.

The subject of the meteorological influence on the river is a very complex and long one, and the outlines only will be given here. In the dry weather the Hooghly contains at an average throughout the year, about 12 parts per 100,000 of suspended matter. It may contain as little as 5 at the end of March or April at a point beyond the reach of the influence of the tides. In the monsoon, or wet weather period, the river frequently contains as much as 250 parts per 100,000 for a considerable number of days. From a careful study of the weather conditions during this and other years, one or two points are very apparent, *viz.*, (1) that the period of maximum amount of silt is caused by rainfall within a distance of about 200 to 300 miles of Calcutta. Heavy rainfall beyond this distance, although it increases the water in the river, does not produce the maximum amount of silt, because during the 300 miles journey a very fair proportion of it has settled out in the slack water. Thus, during a break in the rains, the average amount of silt in the Hooghly is about 100 to 120 parts per 100,000. It is about the same when the flood is due to rainfall in northern and western India. When there is a heavy rainfall in Lower Bengal it is the time when the maximum amount of silt will be obtained from the Hooghly. Rainfall outside this zone has very much less effect on the quantity of silt.

Of course careful enquiry must go on for a large number of years before it will be possible to make an absolutely accurate statement as to the number of days on which the highest amount of silt is to be obtained during the monsoon, but from a very considerable experience of the Hooghly extending over many years, I consider that the following are sufficiently accurate for all practical engineering purposes.

Out of the 123 days of the monsoon, 25 will give the silt capacity at 200 or over, 41 at 150 and over, and 57 at 100. During the 242 days of the dry weather, a fair average for the water uninfluenced by tides is 12 parts per 100,000, but as will be explained later on, this figure does not apply to the Hooghly at Calcutta.

Before leaving this subject, it may be well to point out that the districts largely devoted to dry cultivation are apparently those which give the greatest amount of silt in the river. For the Assam rivers, particularly the Buriganga, Lakhia, the Megna and its many branches, actually contain less silt in the wet weather than they do in the dry. The reason for this is that in the first place by far the greater part of the land of this part of the Province is covered with virgin jungle and the remainder is deep rice cultivation. During the period of rain, the water is standing on the rice fields and in the *bhils*, and any silt settles out; the overflow from these places being comparatively clear. These rivers seldom contain at any time of the year more than 4 parts per 100,000 of suspended matter. Whereas the Ganges (which drains a dry and a wheat growing country) frequently contains as much as 250. These facts concerning the various rivers in Bengal demonstrate how unsafe it is to generalise on the condition of rivers in any particular country; no two things could be more diametrically opposite to each other than the condition of the Ganges and Buriganga in the monsoon. It should also be reported that one of the very large tributaries of the Ganges, *viz.*, the Sone, rises in western India, and crosses a very long extent of country most of which is laterite. A heavy flood in the Sone brings down very large amount of laterite silt, the main characteristic of which is its extraordinary lightness and slowness of sedimentation. During the present year the influence of the Sone has never been felt in the Hooghly at Calcutta, though this has been quite a usual occurrence in other years. The Sone joins the Ganges nearly 300 miles away from Calcutta. This brings us to another point, *viz.*, that the influence of a ***very heavy downpour*** of rain in any particular country is very much greater than the same quantity of rainfall spread over many days. Thus 10 inches of rain in 48 hours falling in the basin of the Sone would make the Hooghly at Calcutta a brick red colour due to laterite silt; whereas 10 inches of rainfall spread over 10 days would not be apparent in Calcutta at all.

The influence of the tides on the condition of silt in the Hooghly at Howrah Bridge and Kidderpore is very remarkable and is entirely different at different

times of the year. In the dry weather, particularly in March and April, at the time of the high spring tides the river at these two points is made muddy by the rising tide. The water coming down the river at this time of the year is about at its purest and may contain as little as 7 or 10 parts per 100,000, but the uprush of strong spring tides will put up the silt in the river from 10 to 40 parts per 100,000. This occurs from about 4, 3, 2, or 1 hour according to the height of the tides. With smaller tides in the months of December, January and February it is not usual for the muddiness due to the rising tide to reach Howrah Bridge, but it frequently reaches Kidderpore at this time. Therefore, even during the dry weather at Kidderpore Docks there may be anything from 10 to 2 hours in the 24 when the silt in the river will reach as much as 45 to 50 parts per 100,000; whilst during the remainder of the 24, it will be considerably less and at dead low water, as low as 10.

The influence of the tide on the monsoon condition of the river also requires some discussion. During the height of the monsoon when the freshets are coming down the river, a 6-knot current is running in the middle of the stream. With the rising tide this begins to slow up and goes on diminishing in velocity until the tide " has made ", the actual current is reversed. At Howrah Bridge it is most unusual during the monsoon season for the tide actually to reverse the current. The most that usually happens is that there is 1 or 2 hours slack water in the centre and a slight up-current in shore. The gradual slowing up of the current due to the rising tide causes a subsidence in the silt held in suspension in the water and our figures demonstrate this beyond all doubt. Thus, it will be observed that on the 25th of July at high tide the suspended matter fell as low as 22 parts per 100,000; whereas the water coming down the river without any slowing up of the current, contained about 90 parts per 100,000. The same thing was also observed on the 9th of August; after slack water the amount of silt was 39·7 and that contained in the flood water about 100 parts. This is a very important fact, because if the water taken from the Hooghly could be confined to 8 hours at the top of the two tides, 60 per cent less silt would be raised at this time, than would be obtained if the pumps worked at dead low tide. The following table gives approximately the amount of silt that would be expected at the height of the tide with various conditions of the rivers :—

Flood water 200 and over pts. p. m. at highest tide 80.

Flood water 120 and over pts p. m. at highest tide 42.

Flood water 80 and over pts. p. m. at highest tide 25.

These figures vary according to the fineness of the silt in the river at the time and with the nearness to the sea of the point of sampling. That is to say, the nearer you get to the sea the longer the flood tide heads up the freshet water, and the greater the purity of the water at high water. The above figures are given for Howrah Bridge but probably 7 to 10 per cent improvement would be observed at Kidderpore. Before finally leaving the subject of the natural condition of rivers, I wish to point out that the early heavy rains usually bring down much more silt than the later downpours of equal intensity. Consequently, the 25 days in which the river is likely to be as high as 200 parts per 100,000 usually occur in July and August with possibly a few days at the end of September and the beginning of October when the final burst or Hatia occurs.

Proceeding now with the actual experiments; to begin with the following points should be made clear :—(1) That, as already stated, in this investigation of roughing filters, preliminary settlement is not made use of; (2) Alum or chemicals are not to be used; and (3) that roughing filtration plant becomes in practice a financial impossibility unless the rate of flow has a minimum of 150 gallons per square foot of sand surface, and 200 is most desirable. Experiments have accordingly been carried out on an ordinary square Patterson filter of 100 square feet surface, working with varying heads and with 3 different grades of sand, *viz.*, 1, 2 and 3.

For the sake of brevity it will be well to describe these results under 3 or 4 different heads, *viz.*, (1) the results obtained with the various sands when the river—

contains	20	parts	per	100,000	or under.
,,	50	,,	,,		,,
,,	100	,,	,,		,,
,,	200	,,	,,		,,

The first of these heads, *viz.*, when the water contains 20, represents the actual condition of affairs during the whole of the dry weather. Unfortunately, the amount of work on these is at present rather small because our work was only commenced on the 4th of July when a certain amount of silt had found its way into the river owing to local rain. The matter, however, will be further investigated in November, if necessary, when the river clears. With the river in this condition, Sand No. 2 with 6 inches of Sand 1 on the surface, working with a 8′ head at a rate of at least 175 gallons per square foot, will reduce the suspended matter down to an average during 24 hours of 1 part per 100 000 without the use of chemicals. A filter of this construction will run for 8 hours without re-washing and with practically no falling off in the yield per square foot. In other words, there is no doubt that under the dry weather conditions (20 parts per 100,000) it will be very easy to remove practically all the silt.

(2) The number of days on which the water coming down the river contains about 50 parts of silt is probably extremely small. It will be confined to a time between October the 15th and November the 1st, that is to say, after the cessation of heavy rain and before the river is properly clear. During the time when the rains are prevalent the silt will reach 80, and after the entire cessation of the rains it will rapidly drop to 20 to 25. From the few experiments already at our disposal, the sand and head given in the previous paragraph will reduce the silt to an average of 3 parts per 100,000 working at 175 gallons per square foot. The filter would probably require washing up every 6 hours.

(3) When the river contains about 100 parts per 100,000, Sand No. 2 only can be used. We have clearly shown from a large series of experiments working on two different systems, that Sand No. 2 with 6 inches of Sand No. 1 on the top, under a head of 10′, will clog up in under an hour and the quantity of water passing through the filter will drop from 200 to about 50 gallons per square foot in this period of time. Working with Sand No. 2 only, and with a head of 8′, at a rate of 175 gallons per square foot, an average of 60 per cent. of the silt only can be removed. There would, I consider, still remain about 40 per cent as an average after filtration at this rate. Practically no difference has been observed with a 10′ head. Furthermore, from the figures we have got, a filter started at 175 gallons per square foot will probably have run down to 100 gallons per square foot at the end of 3 hours

(4) When the river contains 200 and over. In this condition it is practically impossible to handle at all. Sand No. 2 with a head of 10′, working out at 175 gallons per square foot will only remove 50 per cent of the silt and the flow will probably have diminished to 150 gallons per square foot in 2 hours or under. Of course, any other finer grade of sand than No. 2 would block up in a few minutes. Even with this rate (*viz.*, 175 gallons per square foot, 10′ head and sand No. 2) our experiments show that the filter will certainly require washing up at least every 2 hours.

The above figures have been given very carefully on the high side rather than the low. It is possible that with the 100 parts and the 200 parts considerably better average results than 60 per cent purification in the one case and 50 per cent in the other, may be obtained on a 24 hour estimate, owing to the action of the tide. The most striking point that we have arrived at as a result of these experiments is that the economic limit for a single process roughing filter (when no settlements at all can be used) is reached when the

river contains about 60 parts per 100,000 of suspended matter. As long as a river contains no more than this, it would be possible to obtain a water containing as an average about 2—3 parts per 100,000 at a rate of 175 gallons per square foot. Beyond this point settlement or precipitation, or both, is absolutely necessary to obtain this degree of purity.

Similar experiments to those already described have been carried out with Sand No. 3. This sand is a very coarse one. The idea of using this sand was to be quite sure that the sand previously used was not too fine. The square filter working with an 8 feet head under the old arrangement, *viz.*, a commencing with 200 gallons per square foot per hour, gives so little purification that it is impossible to estimate it in percentages, but it is certainly less than 10 with a water containing about 120—130 parts per 100,000. The experiments were carried out on 3 consecutive days and all gave exactly the same results. The filter was not washed up for 24 hours and it shows that the sand has practically no power of removing silt ; the consequence is that it does not block up and the filter runs for 36 or 48 hours without any serious falling off in the quantity of water discharged. The water, however, was of no use to anybody as it contains nearly as much silt as the river itself and shows the same fluctuations due to the tide. Considering the results that have been obtained from Sand No. 2 these results might have been foretold.

Before finally discussing Sand No. 3 as entirely useless, it was decided to try what results could be obtained with a greatly diminished head. Consequently arrangements were made to reduce the working head to 2 feet. Sand No. 3 was still left in the filter. The results obtained by this working are very extraordinary. In the first place it is not possible to get 200 gallons per square foot per hour. At this working head, 190 gallons is about the limit. The results obtained clearly demonstrate the fact that the reduction of head has very slightly altered the purifying capacity of the sand, for the results obtained on the 28th, where controls were taken with each sample, show that in spite of the fact that the tide reduces the quantity of silt in the water a very low level to 30 parts, the purification reported is extremely small, 10 per cent may be looked upon as about the outside.

As regards the blocking up of the filter much the same results were obtained as in the last series, *viz.*, the filter ran for a couple of days without requiring rewashing and with comparatively little falling off in quantity.

Another experiment was also tried, cutting down the filter rate to 5,000 gallons per hour. Unfortunately during this particular experiment the river was pretty clear and the tide was at its highest, so that it is extremely difficult to estimate the amount of purification obtained. At any rate it may be said that it was very small. It would appear therefore that Sand No. 3 under any head and at any rate of flow is entirely unsuited to the silt in the Hooghly water.

Sand No. 3 was removed and Sand No. 2 was substituted. At the head of 2 feet it was found that the flow of water never exceeded 160 gallons per square foot per hour, even though the filter was very carefully washed. With a filter running at this rate almost identical results were obtained with this head as those obtained with the 8 feet and the 10 feet head, *viz.*, on the average working something between 50 and 66 per cent purification was obtained.

In the course of this investigation a very large number of important though small mechanical points were settled. These however cannot be given in this paper.

The main conclusions from the above appear to be :—

(1) That the Ganges and the Hooghly system of rivers in Bengal contains a very large quantity of suspended matter during the rains which comes largely from the dry agricultural land.

(2) Rivers traversing a different kind of country to that of the Ganges basin frequently contain little or no silt in the rains.

(3) The influence of the tides on the quantity of silt in a river water is considerable in any part of the river where the rise and fall

of the tide is felt. In the case of the Hooghly, if pumping could be arranged to take place at high tide, a very much purer water would be obtained.

(4) A single roughing filter without sedimentation or chemicals will give good results with an appropriate sand, using Hooghly water containing about 60 parts per 100,000 of suspended matter. Beyond this point the purification depreciates rapidly.

(5) With water containing about 100 to 150 parts per 100,000, a little more than 66 per cent. of the silt can be removed by a single roughing process.

(6) With water containing above 200 parts per 100,000, 50 per cent is the maximum that can be expected of a single roughing process.

(7) Obviously therefore, when dealing with a water containing more than 100 parts per 100,000, either double roughing or sedimentation with or without chemicals is necessary in order to obtain a water free from silt.

(8) The variation in the head of roughing filters does not appear to influence their purification capacity much ; probably the best economic head is 8 feet.

(9) The grade of sand is the important factor in obtaining good results with roughing filters. This will probably vary with different rivers and therefore should be tested experimentally if a large roughing installation is in contemplation.

" Removal of silt for purification of river water supplies."

The object of this paper is to introduce for discussion the question of the sedimentation for purification of river water supplies and to explain incidentally what the prevailing practice is in the United Provinces with regard to the above. **Object of the paper.**

The principal sources of water supply in the U. P. are from the Ganges, Jumna and Gomti rivers. Agra and Allahabad get their water from the Jumna river, Benares and Cawnpur from the Ganges, Lucknow from the Gomti, and Meerut from the Ganges Canal. The water from these sources is always badly contaminated but for eight months in the year the water is fairly clear and easy to deal with. During the remaining four months it is unusually turbid and the trouble and difficulties experienced in getting a satisfactory effluent are great. **River supplies in the U. P.**

Our difficulties with the crude river water begin at the intake on the river bank. The water is either pumped direct from the river or from an inlet well fed by a gravitation pipe leading to the river and it passes into the pumps without any preliminary treatment. The difference between low and high water level varies between 18 and 20 feet at Agra, Cawnpur, and Lucknow to over 50 feet at Allahabad and Benares. When strainers are employed at the end of the gravitation pipe, or of the suction pipe, and they must always be used, they get speedily choked up with weeds, grass, and other floating matter in the stream and the difficulty experienced in keeping these clean with the river in flood are very great. A properly designed inlet chamber with openings at different levels controlled by sluice valves would do a great deal to remove this difficulty. Where an inlet well is used, the water entering from the river, having its velocity checked in the well speedily deposits a great part of the heavier silt, and if the pumps stop working for a time, when restarted they suck up almost liquid sand which plays havoc with the pump valves and seatings. **Difficulties at the river intake during monsoon period.** **Improved form of intake chamber necessary.**

The provision of a large sludge chamber where the sludge could be drawn off into a sludge pit and removed by a chain and bucket pump would do a good deal to ameliorate these conditions. If in addition to this the water could be made to pass through some form of closed filter (pressure type) which could be cleaned from time to time and the wash water flushed back into the river it would be of the very greatest advantage. Our pumps are designed to raise water from the lowest water level in the river so any rise in the river level would afford sufficient head for working a filter. It is only when the river is high that filtration at the intake is really necessary. The difficulty of working filters at a great depth below ground level would be great but the advantages would also be very appreciable. The wear and tear in the pumps at the unfiltered station would be saved and the economy in working would be secured. In some of the older pumps there is a slip of nearly 30 p. c. at the unfiltered station and this would be a set off against the cost of any system of sedimentation or rough filtering at the intake that could be devised. There would also be the great advantage of getting rid of this heavier silt before the water reached the settling tanks. It is a suggestion which is worth looking into I think. **Sludge Chamber with pump required.** **Roughing filter intake monsoon period.**

From the unfiltered station we next come to the sedimentation basins. At Meerut we have continuous flow settling tanks but at all other stations we have tanks of the intermittent type. As originally designed these tanks were supposed to provide for a minimum settlement of 24 hours at absolute rest, but with the steady growth in demand this period has been much curtailed. Our present tanks contain usually about 12 feet of water, the bottom 3 or 4 feet of depth are reserved for sediment, so the depth available for supply is about 8 or 9 feet, the sides slopes are at $2\frac{1}{2}$ to 1 feet. In modern works these tanks are seldom made less than 25 or 30 feet deep with steep sides slopes so as to prevent the deposit of silt on their banks and the attendant growth of algae. **Sedimentation basins.**

To test the efficacy of short periods of settlement I made two experiments with the raw river water from the Gomti. The first sample was taken in August

when the river was unusually high. The raw water was put into a large 3 gallon jar about 18 inches deep. The coarse sediment settled down at once, while the finer sediment took very long to clear, and at the end of a fortnight there was a belt of 5 inches of quite clear water at the top, this got deeper in hue till it reached the sediment at the bottom. The sample taken in September seemed equally silt laden but it was quite clear in 2½ days, no coagulant was used.

As we know, the time it will take any quantity of water to clear will vary as its depth. The weights of similiar pa rticles vary as the cubes of their diameters, while their superficial areas vary as the square of their diameters. The resistance to settlement is therefore much greater for fine than for coarse particles. When we recollect that the size of these particles may vary from 1/25th of an inch to 1/100,000th of an inch with specific gravities varying from a little over 1 to 2·6 you may expect to find that at the end of any period, say 24 hours, that 60 p. c. of the sediment consisting of the heaviest particles and any light matter entangled with it has reached the bottom and that 40 p. c. is still in suspension. If we divide the water into horizontal layers, we will find the finest and lightest particles in the top layer and the size, weight and density of the particles increasing in each layer as it gets nearer the bottom. Now if we start drawing off the water from the top as we do in the intermittent type of tanks, we start on a comparatively clear layer and the silt in suspension gets gradually greater and greater until we reach the lowest working level in the tanks. In September last at Allahabad I took two samples of water from the settling tanks, No. 1 tank was being drawn on and had been emptied about 7 feet, No. 2 tank had just been filled and the period of settlement had not begun. The samples were drawn from the top water level at the outlet ends. The sample drawn from No. 2 tank which had just been filled was much clearer than the sample from No. 1 tank which was being drawn on. This shows that in the intermittent system off working by drawing off water at considerable depths after short periods of settlement we interfere seriously with the process of sedimentation and get a much worse effluent than can be got from a newly filled tank at the surface. Besides this, we get an effluent which is always varying in quality, which is what we want to avoid for the feed water for filters.

Disadvantages of intermittent type of settlement.

Continuous flow settling tanks.

The Meerut tanks are continuous flow settling tanks. The results obtained in working these tanks have generally been quite good. The tanks are provided with sludge chambers where the very heavy silt is deposited before it enters the settling tanks. These sludge pits are flushed out at intervals.—The rate of flow at Meerut when delivering 1⅓ million gallons per tank is 1/18 inch per second and the duration of stay in the tanks when this quantity is supplied is 16 hours. As a rule the quantity supplied is much less (corresponding to the demand) in the rains. The Meerut settling tanks have baffle walls to regulate the flow. We have not sufficient experimental data to decide exactly what benefit is derived from these baffle walls but it is believed that slow movement with change of direction not only promotes the settling out of suspended matter but also prevents to some extent the growth of algae. It also prevents any large accumulation of silt at one point, and affords security against freshly admitted water finding its way to the outlet without enjoying the normal period of rest.

In the continuous settling basins at Albany N. Y. there are no baffle walls and the water is admitted through 11 inlets on one side and drawn off from 11 outlets exactly opposite. The inlets are rather peculiar and consist of 12" pipes on end, pierced with ⅝ inch holes. These pipes extend 4 feet above the full supply level of the tanks and the supply water finds its way to the tank, as it would do through so many fountains. It also aerates the water, but most authorities are agreed that river waters are generally fully aerated and no further aeration is necessary, and unless the water is drawn from stagnant pools little or no benefit results from aerating river water.

Some experiments were made at Cawnpore, Benares and Lucknow to work the present intermittent tanks as continuous flow tanks, and the results obtained show that the quality of the effluent was improved. At Benares and Cawnpur, the water was admitted into the first tank and then passed through the second

and third tank before being finally taken to the filters. At Lucknow we simply allowed one-third of the quantity to enter each of the three tanks at one end and drew off the corresponding amounts at the outlet end.

A simple expedient for converting the present intermittent type of tank into a continuous flow settling tanks which was suggested for Allahabad is given below. The tanks, worked as intermittent tanks, allowing a day for filling, one for settling, and one for emptying, would yield $2\frac{3}{4}$ millions gallons every third day. If altered as suggested each tank could yield $1\frac{1}{2}$ millions gallons a day or $4\frac{1}{2}$ millions in three days allowing a stay of 36 hours in the tank and a rate of flow of $\frac{1}{18}''$ per second or 400 lineal feet a day. By raising these tanks 3 feet we could increase the output to over 2 millions or decrease the rate of output and increase the period of settlement to 48 hours. **Method of altering an intermittent settling tank to a continuous flow tank with baffle walls.**

ALLAHABAD SETTLING TANKS.

Tank capacity $1\frac{1}{2}$ million gallons daily $= 240{,}000$ c.ft.

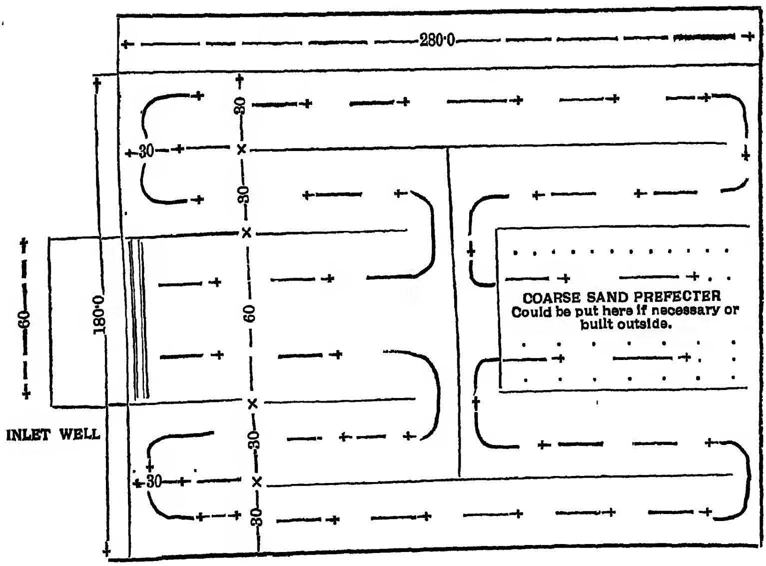
Rate of flow required $\frac{1}{18}''$ per sec. or 400′ per day.

Cross sectional area of flow $60' \times 10' = 600$ sq. ft.

Rate of flow $= \frac{240{,}000}{600} = 400'$ per day.

Each tank can deal with $1\frac{1}{2}$ million gallons.

Period of settlement—36 hours.



As regards the period of sedimentation to be allowed the maximum settlement takes place in the first 24 hours. At Cincinatti Ohio, water was found to settle at the following rate. After 24 hours 62 p. c. After 48 hours 68 p. c. After 72 hours 72 p. c. After 96 hours 76 p. c. This is plain **Period of sedimentation and effect.**

sedimentation. Settlement in the Cawnpore Settling tanks during July and August this year gave the following percentage reductions, about 2½ grains per gallon of Alumino-ferric being used.

PERCENTAGE REDUCTION IN SETTLING TANK.

	COARSE SILT.	FINE SILT.	ALGAE.
July 1912	92·3	85·7	35·1
August 1912	94·3	93·6	43·9

Without alumino-ferric the reduction used to be a bit over 60 p.c. of the total composed almost solely of coarse silt.

It will be noticed that the effect as regards sedimentation of an additional period of settlement for a day or two is small but bacteriologically the effect is most important as will be seen from the following table of results published by the Engineer Commission of the Cincinatti W. W. 1896.

Time of standing in days.	NUMBER OF BACTERIA AT DIFFERENT DEPTHS.		
	2·5	5·	7·5
0	6510	1970	2960
1	6290	2990	880
2	230	320	200
3	200	200	200

The bacteria in the water just above the slime were 1 million per c. c. and in the slime 17 millions per c. c. The difference between storage for 24 hours and 48 hours is most marked and the destruction of 75 p.c. of all bacteria in 3 days is most important, as it is well known that pathogenic bacteria being less hardy are destroyed more easily than the rest.

In Professor Zest's "Experiments on Lake Michigan and Chicago River waters" he states "Experiments seem to show that 99 p.c. typhoid bacili are destroyed in river water in two or three days and in lake water in eight days."

Dr. Houston in his first research report on London water in 1908 says 99 p. c. typhoid bacilli ceased to have any power of multiplication in a week. 80 to 99 p. c. of the balance died in the 2nd week. None were found in 8 weeks. In his 4th Annual report of the Metropolitan Water Board he says "It was shown under laboratory conditions, 99 p. c. of the typhoid bacilli added artificially to raw river water died within a week." He further states "Although fully convinced of the remarkable bacteriological improvement effected by sand filtration I still remain a sceptic as regards its absolute value. There is no convincing evidence that sand filters exercise a special selective action in the separation of pathogenic bacteria and we know that excremental bacteria may pass through them in the same proportion as innocuous microbes." There is very little doubt that every additional day of storage makes for safety. Three weeks storage is to be desired, but if three weeks cannot be got then three days or two days is infinitely better than one day. Sedimentation tanks

are also extremely useful to us as a reserve, if the pumps at the unfiltered station require overhauling we have sufficient water to go on with till things are put right.

No short term of sedimentation will remove fine silt from water. The only practical methods so far in use are the addition of coagulants or preliminary filtration through a bed of coarse sand. Rideal in his book on "Water Purification" says "Many vegetable juices containing tannin are capable of coagulating organic matter in very bad water and rendering them potable. Indians in S. America are in the habit of purifying foul ponds by logs of Peruvian bark, the tannin acting as a precipitant and quinine as a febrifuge. This has been recommended for marshy waters in Italy. Strychnos Pototorum has also been used in India for the same purpose." In making enquiries regarding the water supply of Jaunpur in the U. P. I learnt that the natives there used a seed called "Nirmali" for clarifying the Gumti water. It is stated that it is also used at Ghazipur and other places for clarifying Ganges water. They get 10 seeds for one pice, a single seed, which is the size of a two anna bit is ground up fine and added to the water and is stated to be capable of clarifying about 8 gallons of water. I have not yet been able to identify it under its botanical name or to get an analysis of it. Coagulants.

In dealing however with coagulants on a large scale the only coagulants I propose to consider are Lime, Alumina sulphate, Sulphate of iron and Alumino-ferric. So far as our experiments go we have only had experience of Alumino-ferric. It is cheaper than sulphate of alumina but the cost is fairly high, being Rs. 70 per ton F. O. R. Calcutta. When freight is added the cost comes to between Rs. 80 and Rs. 100 a ton in stations in the U. P. If used at the rate of 2 grs. per gallon, the cost comes to Rs. 10 to Rs. 12 per million gallons filtered and for a 1 million gallons daily supply in the rains the yearly expenditure comes to about Rs. 1,000, more or less. The Lucknow supply which is under 3 millions in the rains cost Rs. 2,000 and the Cawnpore supply which was over four milllons cost Rs. 5000. To use sulphate of alumina or alumino-ferric there must always be a certain amount of alkalinity in the water. The rule we have is that for 1 part of alkalinity in 100,000, one grain of alumino-ferric can be used. The alkalinity in our river supplies is always very much in excess of the amount of alumino-ferric we require to use. As regards the quantity applied, our rule is to allow as a maximum of 0·20 grains for every 0·10 on the turbidity scale. But alumino-ferric is seldom used for small turbidities under 0·5. Our methods of applying the coagulant is to break it into 8 inch cubes and fix it in a cage of wire netting at the inlet, and allow the water to flow over it, the alumino-ferric being renewed at intervals as it is dissolved. This method of applying it has given very good results but it is rather wasteful as a good deal of the hydrate of alumina is carried down by the heavy silt at the inlet. It would be more economical to apply it after the heavy silt has settled. This experiment was tried this year at Benares, the tanks there are being now worked on the continuous flow system, the water passes into tank No. 1 then over a weir to tank No. 2 and then over another weir to tank No. 3 and part of the alumino-ferric was applied on the weir between tanks Nos. 1 and 2 and part on the weir between tanks Nos. 2 and 3. There seems to be a considerable advantage in applying the coagulant in two instalments. In 1910-11 the amount of water treated was 283 million gallons at a cost of Rs. 2,586. In 1911-12 after the changes indicated above were made 281 million gallons were treated at a cost of Rs. 915 only. On account of the high price of sulphate of Alumina and alumino-ferric it is proposed to try experiments with (1) lime, (2) a mixture of lime and alumino-ferric, (3) a mixture of lime and iron sulphate. Dibdin (Purification of Sewage and Water) in his experiments on purification of the London sewage effluent, got excellent results on the destruction of organic matter with 10 and 15 grains of lime per gallon and with a mixture of iron sulphate and lime in the proportion of 3·7 grains lime to 2·5 of iron sulphate and 5 grains of lime to 2 grains of iron sulphate. In his experiments he found iron sulphate acted as efficiently as Alumina sulphate and was much cheaper. It is probable in treating water we will not need so much of these chemicals and the experiments are worth trying. Alumino-ferric.

In Cincinnatti, 4·7 grains of lime per gallon were tried on a fairly soft water, 3·1 grains were in excess of the quantity required to combine with the bicarbonates, and carbonic acid gas had to be added afterwards to remove the excess of lime. The following average results were obtained.

		River water.	Effluent.	Per-centage reduction
Suspended matter	...	273	35	87·2
Bacteria (per c.c.)	...	23,800	1,300	94·5

Sometimes unsatisfactory results are obtained by using too little lime. Lime has three distinct reactions to accomplish (*a*) It must absorb free carbonic acid gas and water can dissolve its own weight of this gas (*b*) It combines with the half bound carbonic acid of the bicarbonates of lime and magnesia (*c*) It transforms magnesia carbonate which is slightly soluble into insoluble hydrate.

Experiments made by Mr. J. W. Hill, Consulting Engineer on Ohio water, gave the following results: Plain water, bacteria 10,000 per c.c., treated with 2·57 grains potash alum 1700, treated with 3·74 grains slaked lime per gallon 55 to 60. Twenty-four hours subsidence was allowed in an ice chest, percentage reduction by alum was 84·22, with lime 99·48 (no filtration). Dibdin in 1896, treated London water with a 9·4 p. c. saturated solution of lime water. Solids were reduced from 24·3 per 1,00,000 to 11·8. Hardness was reduced 63·6 p. c. and bacteria 91·8 p. c.

Algae. There is one other point in connection with settling tanks which requires notice and that is the trouble experienced from Algae. They appear in November and continue till June, but are more especially troublesome during the period from April to June. These organisms multiply in our settling tanks and filters and interfere greatly with the proper working of the filters. For the destruction of Algae in sedimentation basins the use of sulphate of copper is recommended. From experiments made in America and elsewhere it has been found that even so small a quantity as 1 part in 10 millions is algicidal and if this exceedingly small proportion be added to a reservoir in anticipation of growths which have previously given trouble there will be prevention, which in this case is better than cure. Bulletin Nos. 64, 76 and 100 of the Bureau of Plant Industry, Washington, describe the treatment and the results of the treatment of water with copper sulphate. There is also a very useful paper on the subject in vol. XI of 1907 of the Association of Water Works Engineers, by Dr. Kemna of Antwerp. He says 1 in 50 millions killed green algae but 1 in 4 millions was necessary for blue algae. The salt was put in a sack and drawn across the water tied at the end of a boat till it dissolved. It can be applied in a muslin bag at the inlet. In a recent experiment on the Gloucester reservoirs (Journal Soc. Chem. Industry) dated 16th September 1912, 1 part in 3 millions was used sprinkled over the surface of the water as a fine powder. It settled without dissolving and in this way the greatest effect was got at the bottom where it was most desired. They also found ferrous sulphate acted in the same way as copper sulphate.

Preliminary filters. To obtain the best results from the final slow sand filters the crude water supplied to them should be of as uniform a quality as possible, and to secure this a system of dual filtration is often adopted. This means passing the water through a bed of coarse sand or fine gravel before it goes on to the fine sand filters. The process is not new, it may be seen working at York, Leduin and Albany N. Y., Brisbane, and scores of other places. Preliminary filters are also used at most Puech-Chabal installations between the gravel filters and the slow and sand filters.

Dual filtration at Leduin. Dr. Pennick (Amsterdam) gives the following average results for the dual filtration at Leduin.

				Bacteria per c. c.		Liquifying.
Unfiltered water	...	...	...	1950	...	210
Primary filter	...	...	...	250	...	40
Secondary filter	...	...	...	11	...	3

The following details are given at the secondary filters.

Numbers of filters	1	2	3	4	5	6
Number of days in use	2	8	11	31	84	18
Head in centimetres	5	9	19	41	59	41
Total number of colonies	3	2	11	4	8	6
Number liquifying	1	0	3	0	2	0

The Primary filters have gravel ranging from 1/25" to 1/3" in diameter and the secondary filters fine sand. The rate of filtration through the primary filters is 80" per hour (Don and Chisholm Water Purification). **Dual filtration at Albany N. Y.**

There is an interesting article in the Engineering Record of 22nd July 1912 of the working of the Albany filters for the past year. The following figures abstracted from this article may be of interest. The average daily supply of Albany is 21½ million gallons. The water is drawn from the Hudson River, passed through a continuous flow settling tank then through coarse sand filters and finally sterilized with hypochlorite of lime. The size of the settling tank is not given but Hazen in his book on " Filtration of water supplies," states that it has an area of 5 acres and is 9 feet deep and has a capacity of 14,600,000 gallons, which is rather small. There are 16 roughing filters and 8 sand filters, each having an area of 0·7 acres. The operating results of the working during a freshet in March are given below.

	Suspended matters.	Turbidity coefficent.	Percentage reduction in sediment.	Percentage reduction turbidity.
River	170	0 43	...	...
Basin	63	0·19	62·9	20
Primary effluent ...	19	0·04	63·8	75
Secondary effluent ...	0	0	100	100

The average bacterial content of the raw water was 37,000 per c. c. The average reduction in the settling tank was 23·3 for bacteria and 34·6 p. c. for turbidity, no coagulant was used. All the primary filters had sand of an effective size of 0·45 mm. except No. 9 filter which had sand of a size of 0·65 mm. The primary filters with 0·45 mm. sand, had an average run of 35 hours. The loss of head at the start was 0·8 feet and when closed for scraping 2 feet. Rate of working was 70 million gallons per acre and wash water came to 4·1 p. c. For the filter with 0·65 mm. sand the average run was 55 hours at a rate of 79,300,000 gallons. The wash water required was only 2·6 p. c. and the efficiency was the same as the other filters. An experiment is now to be made with sand of 1·2 mm. effective size. The whole of the sand of the primary filter was washed and renewed twice in the year. The average scrapings of the secondary filter was 11·6 times during the year. The average removal of bacteria in the primary filters was 81 p. c. and turbidity 72 p. c. The effluent from the slow sand filters was treated with 0·35 per million of available chlorine and the reduction of bacteria between the inflow to the slow sand filter and the clear

water reservoir is given as 99 p. c. The working expenses per million gallons at Albany are given below.

	Dollars.	Cents.
Pumping station expenses	2	64
Sedimentation Basin	0	3
Preliminary filters	0	53
Secondary filter	1	4
Laboratory	0	53
Hypochlorite of lime	0	26
Superintendence	0	29
Total ...	5	32

York filtration.

At York the primary filters are of the mechanical type used merely as roughing filters. I have no details of the working cost but the results are stated to be very satisfactory.

There can be very little doubt that the adoption of preliminary filtration at our Water Works would result in increased efficiency and output from our slow sand filters and make for Economy in working. As regards the exact type of preliminary filter to be adopted, some experiments will be necessary at each place to determine which type would be the most suitable taking into consideration the crude water to be dealt with.

One great advantage of preliminary filtration through coarse sand is that frog spores are removed and Algae spores are removed to a great extent also. This improves the working of the slow sand filters.

We now arrive at the final stage in the removal of sediment and turbidity and also in the purification of our water, unless the effluent is to be subsequently sterilized by chemical or other means.

Slow sand filters.

Unlike the processes previously described the proper management of a slow sand filter so as to get the best results is a very delicate operation. A knowledge of the proper working of a slow sand filter is very desirable on the part of the man in charge, as processes conducted in ignorance of the rationale of every step seldom attain the high efficiency which follows manipulation with a clear knowledge of all the causes operating to produce a common result.

General rules for managing slow sand filters.

The action of a slow sand filter in removing the residual silt and turbidity is all that really falls within the scope of this paper. If a filter is working efficiently nearly the whole of the remaining silt and turbidity is removed. Only comparatively few of the very finest silt particles and algae spores get through with the effluent and these can only be seen with the aid of a microscope. This, however, is the least important part of the work done by a slow sand filter.

To present in any detail the work done by the slow sand filter from a chemical and biological standpoint with the experimental data which have been collected and the latest theories on the working of these filters would require a separate paper and as it does not come within the scope of the present one it is not proposed to deal with this here.

There are a few general rules for the proper working and control of these filters which may however be given.

(*a*) The quality of the feed water supplied to the filters must be of as uniform a quality as possible. The preliminary processes of sedimentation and clarification must be such as to discount any changes due to the state of the crude water as received from the river.

(*b*) Every filter must have an automatic regulator or controller to automatically record the loss of head and control this rate of flow at the outlet. Regulators to be worked by hand such as we have in the U. P. are not suitable.

(*c*) Filters are often provided at the inlets also with valves controlled by floats to regulate the depth of water on the sand.

(*d*) Any change made in the rate of filtration must not exceed 10 to 20 p. c. of the original rate at any one time without an interval of rest.

(*e*) Every filter should be designed and constructed to filter as evenly as possible over the whole area of its bed. The loss of head in the sand, gravel, and underdrains must be calculated for the maximum rate of filtration to be adopted. The difference between the loss of head from the furthest and nearest points should not exceed 10 to 20 p. c. of the total loss of head so calculated.

(*f*) The effective size of sand to be used should be between 0·2 mm. and 0·35 mm. The fine sand gives better results but clogs sooner. (The effective size of sand is that size of which 10 p. c. of the sample is finer than itself and 90 p. c. is coarser than itself.) The sand should be as uniform as possible and in any case the coefficient of uniformity as found thus $\frac{\text{diam of grain such that 60 p. c. is finer than itself,}}{\text{diam of grain such that 10 p. c. is finer than itself,}}$ should not exceed 3. There should be no particle over 5 mm. in size and the sand should not contain more than 2 p. c. of lime and magnesia combined taken as carbonates.

(*g*) The feed water for a slow sand filter must be introduced as evenly and as gently as possible. If concentrated at one point it is likely to disturb the sand round the point of inlet. It is usual to provide a small circular weir round the inlet when it is at one end, and to lay a small area round it with flagstones in cement on a suitable understructure when the inlet is at the centre. In spite of these precautions the fine silt and organisms are carried forward by the current and the filtering skin forms slowly and imperfectly near the inlet. This is a very weak spot in most filters and it would be better to introduce the water along the whole length of one side at least in the form of an extended weir or through a perforated pipe to prevent this happening.

Rate of filtration.

In the U. P. the average rate of filtration is about 3 inches per hour or about $37\frac{1}{2}$ gallons per sq. ft. per day during the summer and 2 inches per hour or about 25 gallons per sq. ft. per day in the rains. These rates are very low but higher rates do not give satisfactory results with the present condition of things. In England 4 inches per hour or 50 gallons pet sq. ft. usually worked to and higher rates are occasionally adopted. In America where extensive experiments on filtration have been made 6 inches per hour or 75 gallons per sq. ft. per day is often taken as the working rate and 8 inches or 100 gallons has occasionally been worked to for short periods with good results. With proper treatment of the crude water and filters under perfect control, I see no reason why we should not get as good results with rates of 4 inches to 6 inches as we are now getting with rates of between 2 inches and 3 inches.

Maximum loss of head.

In most water works stations in the U. P. the maxm. loss of head worked to in the filters is very small. It never goes above 18 inches and more often

than not does not exceed 12 inches. Working with these low heads minimises the risks of getting bad result from imperfect filters but it means more frequent scraping with the consequent loss in efficiency and economy. In English practice, a maximum loss of head of 36 inches to 40 inches seems about the rule, but in Lawrence quite good results were got with a loss of head of 72 inches. With an effective size of sand of 0·2 mm. the quantities filtered between scrapings were—

With	70	inches	loss	of	head	73	Millions	per	acre.
„	34	„	„	„		27	„	„	„
„	22	„	„	„		16	„	„	„

High heads drive increased quantities of water through any cracks or weak places in a filter, so unless a filter is in very good order these high heads cannot be used.

Experiments were made by the Pittsburg Filtration Commission to estimate the life of a sand filter under varying conditions of turbidity. The filter was composed of 4 feet of fine sand. With a turbidity coefficient of 0·05 a column of water 400 feet was able to pass before the head rose to 4 feet, when the turbidity was doubled the column shortened to 270 feet, and when it was doubled again the column was reduced to 180 feet. The formula deduced is that the period between scrapings calculated in million gallons per acre= $\frac{12}{\text{Turbidity} \times 0\cdot05}$ (Don and Chisholm W. Purification).

Cost of sedimentation and sand filtration in the U. P.

The cost of treatment of water for sedimentation and filtering varies at each station each year according to the amount of silt clearance and renewal of filtering material which is done. I give below the average cost of operations for Benares for the last five years, for an average supply of 1,600 millions gallons yearly, the figures for the other stations are more or less similar but vary slightly with the price of sand.

For stations on or near the Ganges the price of unwashed sand is about Rs. 3-4 per 100 cft.—while at Lucknow and Agra it is much higher.

	Benares. Average of 5 years. From 1907-1912. Rs.
Yearly cost of cleaning settling tanks	1,100
Repairs and upkeep of tanks	82
Cost of sand washing	1,834
Cost of scraping filters	791
Cost of new sand	2,139
Cost of staff on filters	297
Cost of repairs to filters	476
Total ...	6,719

Cost of alumino-ferric is taken separately. Thus the total cost of settling and filtering 1,600 million gallons over a period of five years works out to an average of Rs. 6,719 per year, or to an average of Rs. 4-2 per million gallons. supplied. Of this quantity 283 millions were treated with alumino-ferric in 1911 @ a cost of Rs. 9 per million gallons for alumino-ferric only and 281 million gallons were treated in 1912 at a cost of Rs. 3 per million gallons, The portion of water treated with Alumino-ferric was about 1-6th of the year's supply. If the cost of alumino-ferric is spread over the total supply the additional cost per million gallons filtered comes to Rs. 1-8 in 1911 and As. 8 in 1912. Alumino-ferric was not used prior to 1911. The percentage of extra cost due to alumino-ferric was 36 per cent in 1911 and 12 per cent in 1912 on the cost for settlement and purification only. The number of samples

of unfiltered water tests in 1911-12 for Benares were 77, and the average number of bacteria were 1886 per c. c. The number of samples of filtered waters tested were 354 and the average number of bacteria were 51 per c. c. There were no very great variations in the filtered water results though the crude water varied greatly.

In most of the water works stations in the U. P. the demand for unfiltered water has outstripped the supply and we have to decide how the extra water needed can be obtained. Suggestions for increased supplies required at Water Works Stations in the U. P.

Something can be done by stopping waste, metering, and adopting the district waste meter system, and a little might be saved by supplying unfiltered water for irrigation of lawns and gardens and flushing of drains where the conditions are suitable but some increase is necessary and we have to decide—

(*a*) Whether we should extend our system on the present lines with low rates of filtration,

(*b*) Or take steps to improve the efficiency of our supply by remodelling our settling tanks, allowing more storage, using prefilters, and fitting automatic regulators to the slow sand filters,

(*c*) Or adopting a different method of filtration altogether for the extra supply wanted.

I am personally in favour of (*b*), *i.e.*, improving our present system to start with, and then trying experiments on a small scale to see if there is any other system which would suit us better. If we decide to try experiments there are quite a number of systems one might experiment with. Among mechanical filters we have the Jewell, the Paterson, the Bell, the Candy and a filter by Mather and Platt. For multiple filtration water we have the Puech-Chabal and the Howard systems. Then there are the non-submerged filters which have lately been so much improved by M. Baudet. Besides these there are systems of sterilization by Ozone, Violet rays, Hypochlorite of lime, and free chlorine and those interesting oxidizing agents such as Oxidium, Polarite, and Manganese Permutit. In considering the suitability of any of these we must consider their efficiency not only in the light of the present standards of purity required but what are likely to be the standards of the future. There is no doubt that the bacteriological result of analyses will in future control not only expert but public opinion, and the standard of purity will be raised. The most significant addition of recent times to the conditions to which purified water must conform are those with respect to B. Coli. According to our present Standards so long as the numbers of bacilli do not exceed 100 per c. and B. Coli are practically eliminated it is assumed that there is no danger from pathogenic microbes. This standard is not however regarded as absolute, as on the first outbreak of an epidemic we are advised to sterilize our water by boiling, and this is nothing to be surprised at when we recollect that a wine glass of purified water, well within the prescribed limit, may yet contain over 5,000 microbes some of which might be dangerous. In India many people have great faith in aerated waters. Water charged with carbonic acid tends to inhibit the growth of bacteria but does not render it sterile. Aerated Waters which have been stored for some days do get gradually sterile, but freshly made Aerated Waters are no safer than ordinary water. Slater found hundreds of bacteria per c. c. in aerated waters sold in London and similar results were found in Nurnberg seltzer by Merkel. If the standards of purity for drinking water are raised, and they are sure to be, the future of waterworks Engineering promises to furnish us with some delicate and interesting problems, the solution of which will differ at each place according to the local conditions. To be properly equipped to meet such changes, it is not only necessary that we should keep in touch with the experimental work which is being done elsewhere, but have laboratories of our own where investigations and experiments in water supply problems can be carried out under proper supervision and control.

Experimental Work necessary for new systems of purification and filtration.

Present standards of purity for water supplies likely to be raised.

Aerated waters.

Future of Water Works Engineering. Need of a laboratory.

The subject of water purification will need closer attention in future.

The subject of water purification is a large one and cannot be adequately dealt with in a paper of this sort but I have tried to bring to notice the importance of the work which has to be done. It is commonly believed that the working of sedimentation tanks and sand filters is so entirely simple that anyone is competent to look after it and that the supervision and control of existing water supplies do not need more than the occasional attention of a Sanitary Engineer or Sanitary Commissioner.

If I have succeeded in dispelling some of these misconceptions this paper will have served one of the objects for which it was written.

C. H. WEST,

Sanitary Engineer to Government, U. P.

MECHANICAL FILTERS.

The subject of mechanical filters has been very much before the public of recent times, but there seems to be a good deal of doubt in the minds of many people as to how far those mechanical arrangements can be trusted to remove bacteria from water. The reasons for these doubts need not be discussed: I propose to give a brief account of the results we have obtained in Bengal with the various installations at work there. I do not propose to give a detailed description of the method of action, the designed or the mechanical points in the various types of filters, because I am talking to skilled sanitarians who are conversant with these details. Of course, it is well known that there are two kinds of mechanical filters, (1) *viz.*, the pressure filters, and (2) the gravity filters. We will commence with the former of these :—

PRESSURE MECHANICAL FILTERS.

Name of installation.	Crude water.	Settled water.	Filtered water.	REMARKS.
	Fæcal bacilli in—	Fæcal bacilli in—	Fæcal bacilli in—	
Reliance Mill	·05 c c.	1 c.c.	5 c.c.	
Howah Jute Mill	·001 c.c.	·01 c.c.	·1 c.c.	
Standard Jute Mill ...	·01 c c.	·01 c.c.	1 c.c.	
Kamarhatty Mill	03 c.c.	·03 c c.	1 c c.	
Fort Gloucester Mill ...	·001 c c.	·01 c·c.	·01 c.c.	
Linde Factory	·01 c.c.	...	·01 c.c.	For boiler only.

PRESSURE FILTERS.

The pressure filters may be described as an apparatus through which the water is forced under a considerable head of pressure. In Bengal a very fair number of mills have installed these arrangements in order to remove the silt from the Hooghly water. I herewith give analyses from the various installations in the neighbourhood of Calcutta Before discussing these I must say that my object was to obtain results under absolutely work-a-day conditions. It is not maintained that the filters were worked properly. I did not even take the trouble to investigate whether the alum was added at all, or whether it was added in the correct proportion. I simply give these results as an indication of what may be expected from pressure filters worked by mill engineers (who are usually competent and skilled men) under natural working surroundings. The result on the whole cannot be said to be very satisfactory. In the first place, all the samples were taken during the rains when the river was fairly polluted. The filters remove a very large number of bacteria, and they certainly take out a lage proportion of the silt. When the river is at its worst, they require washing about every two hours, and sometimes oftener. There is usually a certain amount of settlement allowed before passing the water through the filter, but in many cases it is only a matter of very few hours. It is rather difficult to convey a really adequate idea as to what these results and figures mean. In plain English, it may

be said that when there are an enormous number of organisms, fæcal or otherwise, an ordinary pressure filter will take out a very large number of them. Of course, the more these are present in the crude water the higher is the percentage of bacteria removed, but at the same time it cannot be argued that a water which contains one fæcal organism per c. c. is a good water. Of course it *may* be good, but that depends entirely on the source from which the water is taken. Thus, in the dry weather the Hooghly water contains about 1 to 10 organisms fæcal per c. c., and an average pressure filter will frequently give a water containing no fæcal organisms in 5 c. c.. This water may be a good one not because the filter has rendered it so, although it has removed a very fair number of bacteria, but because the river at this period of the year is practically safe. Turning now to the other side of the picture and observing the results during the monsoon, we have a very bad water in the Hooghly, containing a great deal of very recent pollution. At the beginning of the rains the fæcal bacteria usually amount to 1,000 per c. c., and sometimes more but as the rains continue the number usually drops to between 50 and 100 The Jewell pressure filter will approximately reduce this number to 1 per c. c., but still the water cannot be called a good one, partly because the number of fæcal bacteria are too numerous, and, secondly, because pollution in river water is itself dangerous. Therefore, from these results it may be safely said that a pressure filter cannot be looked upon as absolutely safe unless the water, which is supplied to it, has already passed " the safety change." In making these remarks about pressure filters, I shall also like to point out that the makers of the two forms we have studied fully recognize the limitations of these filters, and absolutely refuse to sell them under any guarantee as regards bacteriological efficiency. Again, on no less than three occasions in Bengal these pressure filters have failed to take out cholera vibrios from a polluted mine water. Briefly, the advantages and disadvantages of pressure filters may be stated as follows :—

1. *Advantage.*—They are very useful and compact arrangements for improving the appearance of small quantities of water that is already bacteriologically safe, for they remove many of the bacteria and a great deal of suspended matter and silt.

2. *Disadvantages.*—(*a*) In order to get a decent result from a bacteriological point of view, the head on the filter should never fluctuate. This is extremely difficult to bring about mechanically.

(*b*) In some installations, where settlement is impossible, the difficulties of adding the correct amount of alum are very considerable, and without the proper use of alum the filters give little purification.

(*c*) Pressure filters cannot be constructed with a greater diameter than 8 feet, hence they are practically useless for large installations on account of the initial cost, which for large installations of, say, 10 million gallons per day, would be absolutely prohibitive.

(*d*) It is practically impossible to run the filter at a constant rate of discharge. This is necessary, if high bacteriological purity is desired.

I do not propose to discuss the subject of running cost, as the filters have a very limited use.

Before leaving the subject of pressure filters, I should just like to draw attention to the results that have been obtained in Edinburgh. A report published by Dr. Ritchie and MacGowan shows that the pressure filters there, although starting with a very good water according to our standards, cannot be relied upon to give constant results nor to remove all undesirable bacteria, although they are worked with very great care.

GRAVITY FILTERS.

The modern gravity filter is a most beautiful piece of mechanism. There is no necessity to discuss the merits of the various designs : we have carefully tested the Jewell and the Patterson filters. All of them make use of the same fundamental principles, *viz* :—

(1) A gelatinous film of aluminum oxide is added to the top layer of the sand in order to remove bacteria. This is brought about by adding alum to a water containing the oxicarbonate of lime.

(2) All gravity filters to give good results must work at a constant head and flow per square foot of surface untill they become choked when rewashing is necessary.

The results given show how efficient these filters are: it will be observed that in practically all these a very excellent water has been obtained. Comparison should be made between the crude and the filtered water. A water containing no fæcal organisms in 60 c.c, may be looked upon as being a very sound water for India. Of course the same remarks apply to all filters, including the slow sand filters, *vis.*, that the water should be safe before it arrives at the filters. I do not propose to enlarge on the excellencies of the various results: they are apparent to everybody.

Let us now say a few words upon the possible causes of error which we have met with in the use of these mechanical filters. In the first place, by far the commonest cause of bad results is due to carelessness in adding the alum. We have seen that the addition of this salt is one of the fundamental factors necessary for efficiency, consequently any error in this respect means deficient purification. In the two plants (Jewell and Patterson) that we have had under observation, the method of adding the alum is simple, automatic and accurate. It requires no more attention than pumps, and therefore it cannot be said to be a disadvantage to the filters.

In Dacca we had rather an interesting accident. The water is pumped from the river, and gets about 12 to 15 hours' settlement through some old settling tanks. All the alum (*vis.*, 2 grains per gallon) was added as the water entered the tanks, so that 15 hours afterwards, when the water reached the filters practically all the aluminum oxide had settled out, and the gelatinous layer on the top of the sand was too scanty to remove bacteria properly. It was only necessary to add half the alum on entering the settling tanks and half shortly before the water passed through the filters to give a perfect result.

In another installation, *vis.*, Patterson installation, it was found that the sand was too coarse for the particular type of water. A finer grade gave very excellent results.

Of course careless working in other direction. such as tampering with the automatic governing gear, will naturally upset the filter. These mechanical gravity filters are all carefully adjusted to yield a filtrate at a given rate; and if this is greatly increased, in order to obtain a greater supply of water in the time, naturally the quality deteriorates. In Narainganj we had an instance of this—as soon as the mechanism was put right the purity of the water became satisfactory.

Some seem to think that the amount of silt in the water has a beneficial action in removing bacteria from the water. This may be true in part, though I have never found any evidence in support of the theory. It is necessary, however, that the water should contain sufficient temporary hardness to cause a good precipitate with alum—anything over 5 parts per 100,000 is satisfactory—but under this amount the film is sometimes thin and more lime must be added.

The advantages and disadvantages of these filters are a subject which we can discuss with considerable profit. The advantages are as follows:—

(1) A mechanical gravity filter is capable of giving a pure water at the rate of 100 gallons per square foot per hour. This is 50 times as fast as an ordinary slow sand filter of the same area, which yields about 2 gallons per square foot per hour. It will be perfectly obvious that in certain places a small compact installation may possess many advantages, as compared with the amount of space taken for slow sand filters.

(2) With proper working, there can be no doubt that a very pure water is obtained with this type of filter.

(3) It may be stated that the mechanism, both for the adding of the alum solution and that governing the discharge of the filter, is so

ingenious and accurate that the working is practically automatic, and certainly requires no higher order of intelligence to attend to it than is required by steam pumps.

(4) The initial cost of these filters is considerably less than slow sand filters.

(5) The amount of trouble caused by adverse conditions, such as a very muddy water, is overcome with much less difficulty and less deterioration in the quality of the water than in slow sand filters.

Disadvantages.—(1) All filters, including slow sand filters, are liable to accidents; therefore the water on arrival should have passed the safety change. By this I do not mean that it should be free from all traces of pollution, but that the true fæcal nature of the bacteria should have been altered by natural forces.

(2) The filters require washing up, and filtered water has to be provided for this.

(3) In place where the amount of silt is very great, the amount of water required for washing may at times reach as much as 20 per cent. of the total output of the plant.

(4) The working charges of these filters are high:—

(*a*) The whole water to be pumped has usually to be raised to a greater height than is necessary for slow sand filters.

(*b*) The cost of alum is a big item.

(*c*) The cost of pumping wash-water is also a source of expense. (As an offset to this, most water-works with slow sand filters, taking their supply from big rivers, have to use alumino-ferric to precipitate the silt.)

(5) The trouble and worry necessary in obtaining alum for the precipitation of the suspended matter must be mentioned.

I do not propose to enter into a long discussion of the advantages and disadvantages of the different makes of filters. As I have already said I have only experience of two of these, both of which are extremely efficient. On the whole, there is no doubt whatever that the method of agitating sand with compressed air is superior to rakes, because it allows filters to be made of any shape whatever. With rakes the filter must be circular. Square filters can obviously be made cheaper than circular ones.

Comparing mechanical gravity filters with slow sand filters: given intelligent working, there is very little to choose between them in efficiency. Nowadays it is becoming more and more recognized that *all* types of filters may at times give bad results, and therefore it is necessary for water to be bacteriologically safe before reaching the filter. As to when a water may be considered safe in India is a subject that cannot be dealt with here but there is no doubt that, from all our large lakes and rivers, an absolutely safe water can be obtained for many months in the year. These climatic advantages would obviously simplify the position for mechanical devices. Again, frost is the great enemy of the slow sand filters, and in cold climates, where frost is frequently met with, it would appear that a well-run gravity filter would probably give a better water than a slow sand filter under adverse climatic conditions. Considerable trouble is not infrequently met with from cracks in the masonry of slow sand filters admitting a polluted subsoil water: this is a source of danger which is impossible in the mechanical filter.

There is no doubt that both mechanical and slow sand filters are each suited to special local conditions. There need, however, be no fear in the minds of sanitarians generally concerning the gravity mechanical filter, for it is a very perfect mechanical device for obtaining a water of a very good quality: no sensible individual ever expects that one device will be equally fitted to all situations, or that it will be a panacea for all difficulties in the vast subject of water purification.

SAMPLE OF WATER FROM DACCA—DATED 8TH MAY 1912.

I.—BURI GANG RIVER WATER—

(*a*) Total colonies on agar at 37°—1,710 per cc.

(*b*) Bile salt lactose, medium.

	+	—
1 Tube 20 cc. of water taken ...	1	*Nil*
2 Tubes 10 cc. ditto ..	2	*Nil*
3 Do. 5 cc. ditto ...	3	*Nil*
3 Do. 1 cc. ditto ...	3	*Nil*
3 Do. ·1 cc. ditto	3	*Nil*
3 Do. ·01 cc. ditto ...	*Nil*	3

(*c*) Fæcal bacilli in ·05 cc. and upwards.

Glucose fermenters in ·03 cc.

No streptococci in 20 cc.

Colony No.	Saccharose	Dulcit	Adonit.	Inulin.	Voges and Proskauer	Indol.	Motility	Group	Bacillus.	Group and remarks.
1	—	+	—	—	—	+	—		Schafferi	
2	+	—	—	—	—	+	—		Coscoroba.	
3	—	—	—	—	—	+	—		Vesiculosus .	Group I 5.
4	+	—	—	—	—	+	—		Coscoroba ...	Do. II. 1.
5	—	—	—	—	—	+	—		Vesiculosus ...	Do. IV. 4.
6	+	—	+	—	—	—	—		Gasiformans ...	Class I. 1.
7	+	—	—	—	—	+	—		Coscoroba ...	Do. II. 4.
8	—	—	—	—	—	+	—		Vesiculosus ...	Do. III. 5.
9	—	—	—	—	—	+	—		Ditto.	
10	—	—	—	—	—	+	—		Ditto.	

II.—RIVER WATER—

(*a*) Total colonies on agar at 37°.

(*b*) Bile salt lactose, medium.

	+	—
1 Tube 20 cc. of water taken ...	1	*Nil*
2 Tubes 10 cc. ditto .	2	*Nil*
3 Do. 5 cc. ditto ..	3	*Nil*
3 Do. 1 cc. ditto ...	3	*Nil*
3 Do. 1 cc. ditto ..	3	*Nil*
3 Do. ·01 cc. ditto ...	*Nil*	3

(*c*) Fæcal bacilli in ·05 cc. and upwards.

Glucose fermenters ·05 cc.

No streptococci in 20 cc.

Colony No.	Saccharose	Dulcit	Adonit.	Inulin.	Voges and Proskauer	Indol.	Motility	Group	Bacillus.	Group and remarks.
1	—	—	—	—	—	+	—		Vesiculosus.	
2	+	—	—	—	—	+	—		Coscoroba.	
3	—	—		—	—	+	—		Vesiculosus.	
4		—	—	—	—	+	—		Ditto.	
5	+	—	—	—	+	—	—		Cloacæ.	
6	+	—	+	—	+	—	—		Lactis aerogenes	
7	+	—	+	—	+	—	—		Ditto.	
8	—	—	—	—	—	+	—		Vesiculosus.	
9	—	—	—	—	—	+	—		Ditto	
10	—	—	+	—	—	+	—		Acidi lactici	

III.—SETTLED WATER—

(*a*) Total colonies on agar 37°—880 per cc.

(*b*) Bile salt lactose, medium.

	+	—
1 Tube 20 cc of water taken ...	1	*Nil*
2 Tubes 10 cc. ditto	2	*Nil*
3 Do 5 cc. ditto ...	3	*Nil*
3 Do. 1 cc. ditto ...	3	*Nil*
3 Do. 1 cc. ditto ...	1	2
3 Do. ·01 cc. ditto ...	*Nil*	3

(c) Fæcal bacilli in 1 cc. and upwards.

Colony No.	Saccharose	Dulcit	Adonit.	Inulin.	Voges and Proskauer	Indol.	Motility	Group	Bacillus.	Group and remarks.
1	—	—	—	—	—	+	—		Vesiculosus.	
2	—	—	—	—	—	+	—		Ditto.	
3	—	—	—	—	—	+	—		Ditto.	Group I. 10.
4	—	—	—	—	—	+	—		Ditto.	
5	—	—	—	—	—	+	—		Ditto.	
6	—	—	—	—	—	+	—		Ditto	Class III. 10.
7	—	—	—	—	—	+	—		Ditto.	
8	—	—	—	—	—	+	—		Ditto.	
9	—	—	—	—	—	+	—		Ditto.	
10	—	—	—	—	—	+	—		Ditto.	

IV.—MIXED FILTERED—

(*a*) Total colonies on agar at 37°—10 per cc

(*b*) Bile salt lactose, medium.

	+	—
1 Tube 20 cc. of water taken ...	1	*Nil*
2 Tubes 10 cc ditto ..	*Nil*	2
3 Do. 5 cc. ditto .	*Nil*	3
3 Do. 1 cc. ditto ...	*Nil*	3
3 Do. ·1 cc. ditto ...	*Nil*	3
3 Do. ·01 cc ditto ...	*Nil*	3

(c) Fæcal bacilli in 60 cc. and upwards.

Colony No.	Saccharose	Dulcit	Adonit.	Inulin.	Voges and Proskauer	Indol.	Motility	Group	Bacillus.	Group and remarks.
1	—	—	—	—	—	—	—		Mutabilis.	
2	—	—	—	—	—	—	—		Ditto.	
3	—	—	—	—	—	—	—		Ditto ...	Group I. 10.
4	—	—	—	—	—	—	—		Ditto.	
5	—	—	—	—	—	—	—		Ditto.	
6	—	—	—	—	—	—	—		Ditto ...	Class III. 10.
7	—	—	—	—	—	—	—		Ditto.	
8	—	—	—	—	—	—	—		Ditto.	
9	—	—	—	—	—	—	—		Ditto.	
10	—	—	—	—	—	—	—		Ditto.	

	Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol.	Motility.	Group.	Bacillus.	Group and remarks.

V.—Hydrant Water-Works—

(*a*) Total colonies on agar at 37°—10 per cc.

(*b*) Bile salt lactose, medium.

		+	—
1 Tube	20 cc. of water taken ...	*Nil*	1
2 Tubes	10 cc. ditto ..	*Nil*	2
3 Do.	5 cc. ditto ...	*Nil*	3
3 Do.	1 cc. ditto .	*Nil*	3
3 Do	·1 cc. ditto ..	*Nil*	3
3 Do.	·01 cc. ditto ...	*Nil*	3

(*c*) No fæcal bacilli in 60. cc.

Colony No.: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

VI.—Filter No. I—

(*a*) Total colonies on agar at 37°—10 per cc.

(*b*) Bile salt lactose, medium.

		+	—
1 Tube	20 cc. of water taken ...	*Nil*	1
2 Tubes	10 cc. ditto .	1	1
3 Do.	5 cc. ditto ...	*Nil*	3
3 Do.	1 cc. ditto ...	*Nil*	3
3 Do.	·1 cc. ditto ...	*Nil*	3
3 Do.	·01 cc. ditto ...	*Nil*	3

(*c*) Fæcal bacilli in 60 cc. and upwards

Colony No. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 — No lactose fermenters could be isolated.

VII.—Filter No. II—

(*a*) Total colonies on agar at 37°—20 per cc.

(*b*) Bile salt lactose, medium.

		+	—
1 Tube	20 cc. of water taken ...	*Nil*	1
2 Tubes	10 cc. ditto ...	*Nil*	2
3 Do.	5 cc. ditto ...	1	2
3 Do.	1 cc. ditto ...	*Nil*	3
3 Do.	·1 cc. ditto ...	*Nil*	3
3 Do.	·01 cc. ditto ...	*Nil*	3

(*c*) Fæcal bacilli in 60 cc. and upwards.

Colony No. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 — No lactose fermenters could be isolated.

VIII.—Filter No. III—

(*a*) Total colonies on agar 37°—20 per cc.

(*b*) Bile salt lactose, medium.

		+	—
1 Tube	20 cc. of water taken ...	1	*Nil*
2 Tubes	10 cc. ditto ...	2	*Nil*
3 Do.	5 cc. ditto ...	2	1
3 Do.	1 cc. ditto ...	1	2
3 Do.	·1 cc. ditto ...	*Nil*	3
3 Do.	·01 cc. ditto ...	*Nil*	3

(*c*) Fæcal bacilli in 5 cc. and upwards.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol.	Motility.	Group.	Bacillus.	Group and remarks.
1	+	—	—	—	—	+	—		Coscoroba.	
2	+	—	—	—	—	+	—		Ditto.	
3	+	—	—	—	+	—	—		Cloacæ. ...	Group IV. 1.
4	+	—	—	—	+	—	—		Do.	
5	+	—	—	—	—		—		Gasiformans ...	Class II. 7.
6	+	—	+	—	—	—	—		Ditto.	Do. III. 2
7	+	—	+	—	—	—	—		Ditto.	
8	+	—	+	—	—	—	—		Coscoroba ...	
9	+	—	—	—	—	+	—		Ditto.	
10	+	—	—	—	—	+	—			

IX.—FILTER NO. IV—

(*a*) Total colonies on agar at 37°—20 per cc.

(*b*) Bile salt lactose, medium.

		+	—
1 Tube 20 cc. of water taken	...	*Nil*	1
2 Tubes 10 cc. ditto	...	*Nil*	2
3 Do. 5 cc. ditto	...	*Nil*	3
3 Do. 1 cc ditto.	..	*Nil*	3
3 Do. ·1 cc. ditto.	...	*Nil*	3
3 Do ·01 cc. ditto.	...	*Nil*	3

(c) No fæcal bacilli in 60 cc. .. ..

Colony No.	Saccharose	Dulcit.	Adonit.	Inulin.	Vosges and Prosk	Indol.	Motility.	Group.	Bacillus.	Croup and remarks.
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

X.—FILTER NO. V.—

(*a*) Total colonies on agar at 37°—*nil* in ·1 cc.

(*b*) Bile salt lactose, medium.

		+	—
1 Tube 20 cc. of water taken	...	*Nil*	1
2 Tubes 10 cc. ditto	...	*Nil*	2
3 Do. 5 cc. ditto	...	*Nil*	3
3 Do. 1 cc. ditto	..	1	2
3 Do. ·1 cc ditto	...	*Nil*	3
3 Do. ·01 cc. ditto	...	*Nil*	3

Colony No.	
1	No lactose fermenters could be isolated.
2	
3	
4	
5	
6	
7	
8	
9	
10	

(*c*) Fæcal bacilli in 60 cc. and upwards.

SAMPLE, DACCA. RIVER SETTLING TANK.

Physical appearances.				Colour and transparency.	Dirty white and opaque	Light greenish and clear.
				Smell.	Slight.	Very slight.
Quantitative.						
Total solids ...	. ...	Parts per 100,000		...	13·80	10·20
Temporary hardness	... .	Do.	do.	..	1·00	1 00
Permanent hardness	... ...	Do.	do.	...	3 50	3 50
Total hardness	... ...	Do.	do.		4·50	4·50
Chlorine ...	... ...	Do.	do.	...	·60	·60
Free ammoniacal N.	... ...	Do.	do.	...	·003	·002
Albuminoid ammoniacal N.	... ..	Do.	do.	...	·014	·006
Oxygen absorbed (Tidy's Process)	... ...	Do.	do.	...	·127	·054
Nitrates (as Nitrogen)	... ...	Do.	do.	...	·0·5	·012
Qualitative.						
Nitrites	... ...	...	...	...	*Nil.*	*Nil.*
Sulphates	... ...	...	...	...	Trace.	Trace.
Phosphates	... ...	...	...	...	*Nil.*	*Nil.*
Iron, poisonous metals	... ...	...	...	...	Present ; *nil.*	*Nil.*

4

CHEMICAL ANALYSIS.

SAMPLE, DACCA. FILTERED WATER FROM HYDRANT.

Physical appearances.	COLOURS AND TRANSPARENCY.	COLOURLESS AND CLEAR.
	Smell.	*Nil.*
QUANTITATIVE.		
Total solids	Parts per 100,000	10·00
Temporary hardness	Do. do.	1 00
Permanent hardness	Do. do.	3·50
Total hardness	Do da.	4·50
Chlorine	Do. do	·60
Free ammoniacal N.	Do. do.	·003
Albuminoid ammoniacal N. ...	Do. do.	·004
Oxygen absorbed (Tidy's Process) ...	Do. do.	·036
Nitrates (as Nitrogen)	Do. do.	0·5
QUALITATIVE.		
Nitrites...		*Nil.*
Sulphates		Trace.
Phosphates		*Nil.*
Iron, prisonous metals		*Nil*

REPORT ON THE WATER—SUPPLY OF DACCA MUNICIPALITY.

SAMPLES NOS. 1 and 2 taken from the river itself and the pumped river water show that the water in the Buri Ganga is polluted a good deal in the neighbourhood of the intake. Fæcal bacilli are present about 20 to the cc. The mixture of organisms is highly suggestive of recent fæcal contamination.

Chemically the water is a fairly good one for a crude river water ; the total hardness is only 4·5 degrees.

Sample No. 3 —Settled water (after about 12 hours' settlement and treated with aluminum sulphate) shows fæcal organism in 1 cc. or rather more. The bacilli have undergone considerable change and have now lost to a considerable extent their true fæcal arrangement.

Chemically, the settled water shows a considerable improvement in the amount of organic matter present. The albuminoid ammonia and oxidisable matter both being reduced considerably ; apparently no sulphate of aluminum remains in solution in the water.

Sample taken from each of the five filters shows that in four out of five fæcal organisms are not present in 60 cc., the total colonies being something between 10 and 20 In one filter, no. 3, the organisms are present in 5 cc. Those isolated are similar to those in the settled water.

Samples taken from the mixed filtered water and from hydrants show no organism in 60 cc.

On the whole the installation is working extremely well.

SAMPLES OF WATER FROM DACCA WATER-WORKS—DATED 16TH SEPTEMBER 1912.

I.—RIVER WATER—

(*a*) Total colonies on agar at 37°—370 per cc.

(*b*) Bile salt lactose, medium.

	+	—
1 Tube 20 cc. of water taken ...	1	*Nil*
2 Tubes 10 cc. ditto ...	2	*Nil*
3 Do. 5 cc. ditto ...	3	*Nil*
3 Do. 1 cc. ditto ...	3	*Nil*
3 Do. ·1 cc. ditto .	1	2
3 Do. ·01 cc. ditto ...	*Nil*	3

(*c*) Fæcal bacilli in 1 cc. and upwards.

Glucose fermenters in ·1 cc.

No streptococci in 20 cc.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol.	Motility.	Group.	Bacillus.	Group and remarks.
1	—	—	—	—	—	+	—		Vesiculosus.	
2	—	+	—	—	—	+	—		Schafferi ...	Group I. 5.
3	+	—	—	—	—	+	—		Coscoroba ...	Do. II. 1.
4	—	—	—	—	—	+	—		Vesiculosus ...	Do. III. *Nil.*
5	+	—	—	—	—	+	—		Coscoroba ...	Do. IV. 4.
6	+	—	+	—	—	—	—		Lactis ærogenes	Class I. 1.
7	—	—	—	—	—	+	—		Vesiculosus ...	Do. II. 4.
8	—	—	—	—	—	+	—		Ditto ...	Do. III. 5.
9	+	—	—	—	—	+	—		Coscoroba ...	
10	—	—	—	—	—	+	—		Vesiculosus ...	

II.—SETTLED WATER—

(*a*) Total colonies on agar at 37°.

(*b*) Bile salt lactose, medium.

	+	—
1 Tube 20 cc. of water taken ...	1	*Nil*
2 Tubes 10 cc. of water taken ...	2	*Nil*
3 Do. 5 cc. ditto ...	3	*Nil*
3 Do. 1 cc ditto ...	1	2
3 Do. ·1 cc. ditto ...	*Nil*	3
3 Do. ·01 cc. ditto ...	*Nil*	3

(*c*) Fæcal bacilli in 5 cc. and upwards.

Glucose fermenters in 5 cc.

No streptococci in 20 cc.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol.	Motility.	Group.	Bacillus.	Group and remarks.
1	—	+	—	—	—	+	—		Schafferi.	
2	+	—	—	—	—	+	—		Coscoroba.	
3	+	—	—	—	—	+	—		Ditto ...	Group I. *Nil.*
4	-	+	—	—	—	+	—		Schafferi ...	Do. II. 5.
5	+	—	—	—	—	+	—		Coscoroba ...	Do. III. *Nil.*
6	+	—	—	-	-	+	—		Ditto ...	Do. IV. 5.
7	—	+	—	—	—	+	—		Schafferi.	
8	+	—	—	—	—	+	—		Coscoroba ...	Class I. 5.
9	—	+	—	—	—	+	—		Schafferi ...	Do. II. 5.
10	—	+	—	-	—	+	—		Ditto.	

III.—FILTERED WATER AS IT COMES OUT FROM FILTERS—

(*a*) Total colonies on agar at 37°—20 per cc.

(*b*) Bile salt lactose, medium.

	+	—
1 Tube 20 cc. of water taken ...	*Nil*	1
2 Tubes 10 cc. ditto ...	*Nil*	2
3 Do 5 cc. ditto ...	*Nil*	3
3 Do. 1 cc. ditto ...	*Nil*	3
3 Do. ·1 cc. ditto ...	*Nil*	3
3 Do. ·01 cc. ditto ...	*Nil*	3

(*c*) Fæcal bacilli in 60 cc.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol.	Motility.	Group.	Bacillus.	Group and remarks.
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

IV.—CLEAR WATER RESERVOIR—

(*a*) Total colonies on agar at 37°—about 3,000 per cc.

(*b*) Bile salt lactose, medium.

	+	—
1 Tube 20 cc. of water taken ...	1	*Nil*
2 Tubes 10 cc. ditto ...	2	*Nil*
3 Do. 5 cc. ditto ...	2	1
3 Do. 1 cc. ditto ...	1	2
3 Do. ·1 cc. ditto ...	*Nil*	3
3 Do. ·01 cc. ditto ...	*Nil*	3

(*c*) Fæcal bacilli in 5 cc. and upwards.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol.	Motility.	Group.	Bacillus.	Group and remarks.
1	—	—	—	—	—	+	—		Vesiculosus.	
2	—	—	—	—	—	+	—		Ditto.	
3	—	—	—	—	—	+	—		Ditto ...	Group I. 9.
4	—	—	—	—	—	+	—		Ditto ...	Do. IV. 1.
5	—	—	—	—	—	+	—		Ditto ...	Class II. 1.
6	—	—	—	—	—	+	—		Ditto ...	Do. III. 9.
7	—	—	—	—	—	+	—		Ditto .	
8	—	—	—	-	—	+	—		Ditto ...	
9	—	—	—	—	—	+	—		Ditto ...	
10	+	—	+	—	+	—	—		Lactis ærogenes	

SAMPLE OF WATER FROM DACCA—Dated 16th SEPTEMBER 1912.

V.—Tap in Water Works—			Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin	Vosges & Prosk.	Indol.	Motility.	Group.	Bacillus	Group and remarks.
(a) Total colonies on agar at 37°—about 5,000 per cc.													
(b) Bile salt lactose, medium.	+	—											
1 Tube 20 cc. of water taken ...	1	*Nil*	1	—	+	—	—	—	+	—		Schafferi	
2 Tubes 10 cc. ditto ...	1	1	2	—	+	—	—	—	+	—		Ditto.	
3 Do. 5 cc. ditto ...	2	1	3	—	—	—	—	—	+	—		Vesiculosus ...	Group I. 5.
3 Do. 1 cc. ditto ...	1	2	4	—	+	—	—	—	+	—		Schafferi ...	Do. II. 5.
3 Do. ·1 cc. ditto ...	*Nil*	3	5	—	—	—	—	—	+	—		Vesiculosus ...	
3 Do. ·01 cc. ditto ...	*Nil*	3	6	—	—	—	—	—	+	—		Ditto.	Class I. 5.
			7	—	+	—	—	—	+	—		Schafferi ...	Do. III. 5.
			8	—	—	—	—	—	+	—		Vesiculosus ...	
(c) Fæcal bacilli in 5 cc. and upwards.			9	—	—	—	—	—	+	—		Ditto.	
			10	—	+	—	—	—	+	—		Schafferi.	

CHEMICAL ANALYSIS.

Sample—Dacca. River. Filtered.

Physical Appearances.			River	Filtered
Colour and Transparency.			Greenish and Hazy.	Colourless and clear.
Smell.			Vegetative.	Very slight.
Quantitative.				
Total solids	Parts per 100,000	...	5·20	8·00
Temporary hardness	Do. do.	...	*Nil.*	*Nil*
Permanent hardness	Do. do.	...	2·50	3·00
Total hardness	Do. do	...	2·50	3·00
Chlorine	Do. do.	...	·45	·45
Free ammoniacal N	Do. do.	...	·004	Trace.
Albuminoid ammoniacal N	Do. do.	...	·010	·003
Oxygen absorbed (Tidy's Process) ...	Do. do.	...	·120	·031
Nitrates (as Nitrogen)	Do. do	...	·010	·015
Qualitative.				
Nitrites	... ...	...	*Nil*	*Nil*
Sulphates	... ...	...	*Nil*	Trace.
Phosphates	... ...	...	*Nil*	*Nil*
Iron, poisonous metals ...	... ...	...	Minute trace, *nil*	*Nil*

REPORT ON THE ANALYSIS OF WATER SUPPLY, DACCA.

Sample taken from the river water shows signs of a fair amount of recent pollution. Fæcal organisms being present in 1 cc.

The settled water shows that there is some slight numerical improvement, but it confirms the opinion that the pollution is of a very undesirable nature.

Sample taken from the filtered water shows that there are no fæcal organisms in 60 cc. which is an extremely good water.

Sample taken from the clear water reservoir, however, shows that fæcal organisms are present in 5 cc. This is evidently due to some leakage into the underground reservoir either through the roof or through cracks.

Sample taken from the hydrant confirms this result, and also shows that the pollution so added is of a most unsatisfactory nature.

The analysis suggests the possibility that water from the settling tank is actually finding its way unpurified into the filtered water reservoir.

Chemically, the purified water is a very good one.

SAMPLES OF WATER FROM NARAINGANJ—DATED 16TH SEPTEMBER 1912.

I.—River water—

(a) Total colonies on agar at 37°.

(b) Bile salt lactose, medium—

		+	—
1 Tube 20 cc. of water taken	...	1	*Nil*
2 Tubes 10 cc. ditto	...	2	*Nil*
3 Do. 5 cc. ditto	...	3	*Nil*
3 Do. 1 cc. ditto	...	3	*Nil*
3 Do. ·1 cc. ditto	...	3	*Nil*
3 Do. ·01 cc. ditto	...	*Nil*	3

(c) Fæcal bacilli in ·05 cc. and upwards.

Glucose fermenters in ·03 cc.

No streptococci in 20 cc.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol.	Motility.	Group.	Bacillus.	Group and remarks.
1	—	—	—	—	—	+	—		Vesiculosus	
2	+	—	—	—	+	—	—		Cloacæ ...	Group I. 7.
3	—	—	—	—	—	+	—		Vesiculosus ...	Do. II. *Nil.*
4	—	—	—	—	—	+	—		Ditto ...	Do. III. 2.
5	—	—	—	—	—	+	—		Ditto ...	Do. IV. 1.
6	—	—	—	—	—	+	—		Ditto ...	Class I. *Nil.*
7	—	—	—	—	—	+	—		Ditto ...	Do. II. 2.
8	+	+	+	—	+	—	—		*67* ...	Do. III 8.
9	—	—	—	—	—	+	—		Vesiculosus.	
10	+	+	—	—	—	+	—		Neapolitanus.	

II.—Settled water—

(a) Total colonies on agar at 37°—1,070 per cc.

(b) Bile salt lactose, medium—

		+	—
1 Tube 20 cc. of water taken	...	1	*Nil*
2 Tubes 10 cc. ditto	...	2	*Nil*
3 Do. 5 cc. ditto	...	2	1
3 Do. 1 cc. ditto	...	*Nil*	3
3 Do. ·1 cc. ditto	...	*Nil*	3
3 Do. ·01 cc. ditto	...	*Nil*	3

(c) Fæcal bacilli in 5 cc. and upwards.

Glucose fermenters in 5 cc.

No streptococci in 20 cc.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol.	Motility.	Group.	Bacillus.	Group and remarks.
1	—	—	—	—	—	+	—		Vesiculosus.	
2	—	—	—	—	—	+	—		Ditto.	
3	—	—	—	—	—	+	—		Ditto ...	Group I. 10.
4	—	—	—	—	—	+	—		Ditto.	
5	—	—	—	—	—	+	—		Ditto ...	Class III. 10.
6	—	—	—	—	—	+	—		Ditto.	
7	—	—	—	—	—	+	—		Ditto.	
8	—	—	—	—	—	+	—		Ditto.	
9	—	—	—	—	—	+	—		Ditto.	
10	—	—	—	—	—	+	—		Ditto.	

III.—Clear water Reservoir—

(a) Total colonies on agar at 37°—180 per cc.

(b) Bile salt lactose, medium—

		+	—
1 Tube 20 cc. of water taken	...	*Nil*	1
2 Tubes 10 cc. ditto	...	1	1
3 Do. 5 cc. ditto	...	*Nil*	3
3 Do. 1 cc. ditto	...	*Nil*	3
3 Do. ·1 cc. ditto	...	*Nil*	3
3 Do. ·01 cc. ditto	...	*Nil*	3

(c) Fæcal bacilli in 60 cc. and upwards.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol.	Motility.	Group.	Bacillus.	Group and remarks.
1	+	+	—	—	—	+	—		Neapolitanus.	
2	+	—	—	—	+	—	+		Cloacæ.	
3	+	+	—	—	—	+	—		Neapolitanus ...	Group III. 9.
4	+	+	—	—	—	+	—		Ditto ...	Do. IV. 1.
5	+	+	—	—	—	+	—		Ditto.	
6	+	+	—	—	—	+	—		Ditto.	Class II. 9.
7	+	+	—	—	—	+	—		D.tto ...	Do. III. 1.
8	+	+	—	—	—	+	—		Ditto.	
9	+	+	—	—	—	+	—		Ditto.	
10	+	+	—	—	—	+	—		Ditto.	

IV.—Tap near head works—

(a) Total colonies on agar at 37°—130 per cc.

(b) Bile salt lactose, medium—

		+	—
1 Tube 20 cc. of water taken	...	*Nil*	1
2 Tubes 10 cc. ditto	...	*Nil*	2
3 Do. 5 cc. ditto	...	2	1
3 Do. 1 cc. ditto	...	*Nil*	3
3 Do. ·1 cc. ditto	...	*Nil*	3
3 Do. ·01 cc. ditto	...	*Nil*	3

(c) Fæcal bacilli in 30 cc. and upwards.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol.	Motility.	Group.	Bacillus.	Group and remarks.
1	+	—	—	—	—	+	—		Coscoroba.	
2	+	—	—	—	—	+	—		Ditto ...	Group IV. 10.
3	+	—	—	—	—	+	—		Ditto.	
4	+	—	—	—	—	+	—		Ditto.	
5	+	—	—	—	—	+	—		Ditto ...	Class II. 10.
6	+	—	—	—	—	+	—		Ditto.	
7	+	—	—	—	—	+	—		Ditto.	
8	+	—	—	—	—	+	—		Ditto.	
9	+	—	—	—	—	+	—		Ditto.	
10	+	—	—	—	—	+	—		Ditto.	

CHEMICAL ANALYSIS.

SAMPLE—NARAYANGUNJ. RIVER. FILTERED.

Physical appearances.		River	Filtered
	Colour and Transparency.	Greenish and hazy.	Colourless and clear.
	Smell.	Vegetative.	Very slight.
Quantitative.			
Total solids	Parts per 100,000 ...	4·00	5·90
Temporary hardness	Do. do. ...	*Nil*	*Nil*
Permanent hardness	Do. do. ...	2·50	2·50
Total hardness	Do. do. ...	2·50	2·50
Chlorine	Do. do. ...	·45	·45
Free ammoniacal N.	Do. do. ...	·003	·002
Albuminoid ammoniacal N.	Do. do. ...	·009	·005
Oxygen absorbed (Tidy's Process) ...	Do. do. ...	·140	·052
Nitrates (as Nitogen)	Do. do. ...	Trace.	·002
Qualitative.			
Nitrites	... ...	*Nil*	*Nil*
Sulphates	... ...	*Nil*	Trace.
Phosphates	... ...	*Nil*	*Nil*
Iron, poisonous metals	... ...	*Nil*	*Nil*

REPORT ON THE ANALYSIS OF WATER-SUPPLY, NARAYANGUNJ.

THE river water, although considerably polluted, shows some signs of self-purification. Fæcal bacilli are present, about 20 to the c. c.

The settled water shows a very considerable improvement, fæcal bacteria being present in 1 in 5 c. c.

Sample from the clear water reservoir shows that the filtered water is a very good one. There being about 1 fæcal organism in 60 c. c.

The same remarks apply to the water in the mains.

Chemically, the final water is a good one.

SAMPLES OF WATER FROM JESSOP'S FILTER WORKING NEAR HOWRAH BRIDGE—DATED 14TH SEPTEMBER 1912.

RIVER WATER as it flows in—

(*a*) Total colonies on agar at 37°—Countless in ·1 cc.

(*b*) Bile salt lactose, medium.

		+	—
1 Tube	20 cc. of water taken ...	1	*Nil.*
2 Tubes	10 cc. ditto ...	2	*Nil.*
3 Do.	5 cc. ditto ...	3	*Nil.*
3 Do.	1 cc. ditto ...	3	*Nil.*
3 Do.	·1 cc. ditto ...	1	2
3 Do.	·01 cc. ditto ...	1	2

(*c*) Fæcal bacilli in 1 cc. and upwards.

Glucose fermenters in ·003 cc.

No streptococci in 20 cc.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol	Motility.	Group.	Bacillus.	Group and remarks.
1	—	—	-	—	—	+	—		Vesiculosus.	
2	—	—	—	—	—	+	—		Ditto.	
3	—	—		—	—	+	—		Ditto ...	Group I. 5.
4	—	—	+	—	-	+	—		Acidi lactici ...	Do. II. *Nil.*
5	—	—	—	—	—	+			Vesiculosus ...	Do. III. 1.
6	+	—	—	-	—	+	-		Coscoroba ...	Do. IV. 3.
7	-	—	+	—	—	+	—		Acidi lactici ...	Class I. *Nil.*
8	+	—	+		—	—	-		Gasiformans ...	Do. II. 6.
9	+	—	—	—	—	+	—		Coscoroba ...	Do. III. 4.
10	+	+	-	—	—	+	—		Neapolitanus	

SETTLED WATER—

(*a*) Total colonies on agar at 37°—1,710 per cc.

(*b*) Bile salt lactose, medium.

		+	—
1 Tube	20 cc. of water taken ...	1	*Nil.*
2 Tubes	10 cc. ditto ...	2	*Nil.*
3 Do.	5 cc. ditto ...	3	*Nil.*
3 Do.	1 cc. ditto ...	2	1
3 Do.	·1 cc. ditto ...	*Nil.*	3
3 Do.	·01 cc. ditto ...	*Nil.*	3

(*c*) Fæcal bacilli in 1 cc. and upwards.

Glucose fermenters in 1 cc.

No streptococci in 20 cc.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol	Motility.	Group.	Bacillus.	Group and remarks.
1	+	—	—	—	—	+	—		Coscoroba.	
2	—	+	—	-	—	+	—		Schafferi.	
3	+	+	—	—	-	+	—		Neapolitanus ...	Group I. 2.
4	+	+	—	—	-	+	—		Ditto ...	Do. II. 2.
5	+	+	—	—	—	+	—		Ditto ...	Do. III. 5.
6	+	+	—	—	-	+	—		Ditto ...	Do IV. 1.
7	—	—	—	—	—	-	-		Mutabilis ...	Class I. 2.
8	—	—	—	—	—	—	—		Ditto ...	Do. II. 6.
9	+	+	—	—	—	+	—		Neapolitanus ...	Do. III. 2.
10	—	+	—	-	—	+	—		Schafferi.	

FILTERED WATER—

(*a*) Total colonies on agar at 37°—290 per cc.

(*b*) Bile salt lactose, medium.

		+	—
1 Tube	20 cc. of water taken ...	1	*Nil.*
2 Tubes	10 cc. ditto ...	1	1
3 Do.	5 cc. ditto ...	*Nil.*	3
3 Do.	1 cc. ditto ...	*Nil*	3
3 Do.	·1 cc. ditto ...	*Nil.*	3
3 Do.	·01 cc. ditto ...	*Nil.*	3

(*c*) Fæcal bacilli in 20 cc. and upwards.

Colony No.	Saccharose.	Dulcit.	Adonit.	Inulin.	Vosges & Prosk.	Indol	Motility.	Group.	Bacillus.	Group and remarks.
1	—	+	—	—	—	+	—		Schafferi.	
2	—	+	-	-	—	+	-		Ditto.	
3	+	+	—	-	—	+	—		Neapolitanus ...	Group I. 2.
4	—	—	—	-	—	+	—		Vesiculosus ...	Do. II. 7.
5	—	—	—	-	—	+	—		Ditto ...	Do. III. 1.
6	—	+	—	—	-	+	—		Schafferi ...	Class I. 7.
7	-	+	—	—	—	+	—		Ditto ...	Do. II. 1.
8	—	+	—	—		+	—		Ditto ...	Do. III. 2.
9	—	+	—	—	—	+	-		Ditto.	
10	—	+	—	—	—	+	—		Ditto.	

CHEMICAL ANALYSIS.

Sample—Jessop & Co.'s		River.	Filtered
Physical appearances.	Colour and Transparency.	Brown and opaque.	Colourless and clear.
	Smell.	Slightly vegetative.	*Nil.*
Quantitative.			
Total solids	Parts per 100,000 ...	87·70	17·80
Temporary hardness	Do. do. ..	4·25	2·00
Permanent do.	Do. do. ...	·200	5·50
Total hardness	Do. do. ...	6·25	7·50
Chlorine	Do. do. ...	·70	·70
Free ammoniacal N.	Do. do. ...	·002	·002
Albuminoid ammoniacal N.	Do. do. ...	·020	·003
Oxygen absorbed (Tidy's Process) ...	Do. do. ...	·258	·040
Nitrites (as Nitrogen)	Do. do. ...	·022	·023
Qualitative.			
Nitrites	...	*Nil.*	*Nil.*
Sulphates	...	Minute trace.	Present.
Phosphates	...	*Nil.*	*Nil.*
Iron, poisonous metals	...	Present, *nil.*	*Nil.*

REPORT ON MECHANICAL FILTERS AT MESSRS. JESSOP & CO.'S WORKS.

Samples taken on the 14th September 1912.—Samples taken from the river shows that the fæcal organisms are present in about a 300 to the cc. Most of these, however, are of the glucose fermenting type, the river showing signs of considerable self-purification. Total colonies are countless in ·1 cc.

The settled water shows fæcal bacilli in about 1 cc. The total colony counts are 1,710; the bacteria isolated are worse to those from the river and show that the quality of the water varies considerably from time to time.

The filtered water shows fæcal organisms in 1 in 20 cc. and total colonies about 200. This is a satisfactory result on the whole.

Chemically, there is a great reduction in the amount of albuminoid ammonia, *viz.*, from ·02 to ·003, and the amount of oxygen absorption power is very greatly diminished. On the whole the installation is working very satisfactorily.

W. W. CLEMESHA, M.D., D.P.H., *Major, I.M.S.*,

Sanitary Commissioner for Bengal.

MECHANICAL FILTERS

FOR

TOWN WATER-SUPPLY

A BRIEF ACCOUNT OF THE PRINCIPLES OF CONSTRUCTION

INCLUDING

A DESCRIPTION OF THE JEWELL FILTERS IN OPERATION IN MYSORE.

By

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MECHANICAL FILTERS FOR TOWN WATER SUPPLY.

Preliminary.

THE importance of a good water supply to any community cannot be over-estimated. The value of good potable water has been established beyond doubt. Of the benefits conferred on any community by modern civilisation, few can compare with that of an adequate supply of potable water; and all civilised nations recognise it as one of the foremost duties of every municipal management.

Even the ancients knew the importance of pure water and its purification by filtration was practised by them. "Bolton's Ancient Methods of Filtration" describes many curious devices used in olden times. The coagulation of water by alumina was known to the Hindus from time immemorial.

It is a notorious fact that many dreaded diseases come from impure or polluted water supply, and the process of filtration has been the logical outcome of an effort to safeguard the community against such diseases.

The enormous advance that has taken place of late in the science of bacteriology has thrown a flood of light on the theory and practice of filtration; and sanitary engineers have not been slow in profiting by the knowledge, and evolving very efficient types of filters. Besides improving to a remarkable degree the physical appearance of the water, a modern filter is able to remove from it a very large percentage of bacteria. Its efficiency is gauged by the percentage of removal effected, as safety or immunity from diseases is best obtained when the percentage or removal is greatest.

The standard usually prescribed is that at no time shall there be more than 100 bacteria per c.c. in the filtered water, when the raw water contains less than 3,000 per c.c., and, when the number of bacteria in the raw water exceeds 3,000 per c.c., the reduction of. bacteria in the filtered water shall not be less than 97 per c.c.

There are many processes of purification of water, but we are concerned at present only with what is called the "Mechanical System of Filtration."

My experience of these filters has been gained during the course of erection and subsequent maintenance of the two installations at Bethamangala and Bangalore during the last eight years. The figures relating to the cost of maintenance and working charges have been taken from the records of the Bangalore filters.

The name "Mechanical Filters" is applied to a type of filters which possess certain distinctive features, *viz.*—

(1) A very rapid rate of filtration,

(2) The use of a coagulant, and

(3) The application of a mechanical device for cleaning the sand.

"Rapid Filters" is a better name to apply to these filters as the rapidity of filtration (about 125 million gallons per acre per day) is the real predominating feature and not the mere mechanical means for washing the bed. Another name by which they are often known is "American Filters," America being, as it were, the birthplace of this system.

2. Typical Features.

Rapid Filters were first invented in America to deal with very muddy water by the use of coagulants and subsequent filtration for manufacturing purposes. Their power to effect, bacterial purification was discovered much later and, not until, it was corroborated by a number of elaborate experiments, that their suitability for town supply was recognised and public confidence established.

These filters resemble the Old Sand Filters in so far that sand is generally the medium employed in both, but beyond this the resemblance ceases. The other essential characteristics, *viz.*, rapidity of filtration, coagulation and washing of sand, give rise to important differences in construction.

Rapid Filters have been known to give the same good result as the Slow Sand Filters and, in some cases, even better when operated with care. But they distinctly score over the Slow Sand Filters in that the sand once put in the filter remains there for ever and is, for all practical purposes, "untouched by human hand." Further, should a filter get contaminated by accident or otherwise, it can be readly sterilised either by boiling the sand with live steam or by the application of suitable chemicals.

There are two distinct types of rapid filters in use and these are known as—

(*a*) Pressure Filters.

(*b*) Gravity Filters.

They are both operated on the same principle with the same loss of head. In a Pressure Filter, the sand or other special material is contained in a closed vessel and the water is under pressure all the time. The Gravity Filter, on the other hand, as the name implies, is open to the atmosphere and works by gravity only. Their relative merits and disadvantages may be summed up as follows: Pressure Filters are most suitable for a house, a manufactory, or a very small town, compact and easily set up, but somewhat inferior in point of efficiency. Gravity Filters are suitable for large towns, more precise in action and give higher efficiency.

Pressure Filters have proved themselves so handy in the installations set up by the writer for the water supply to the towns of Harihar and Shimoga, that he would strongly recommend them for consideration in cases where a supply of tolerably pure water is required for a small population of, say, up to 10,000.

Experience has proved that, without being very expensive, these filters can be maintained in a good condition more easily than an ordinary sand filter, especially where the agency to look after them is not of the best, such as we find in most mofussil towns. Under such conditions a neglected sand filter soon becomes a breeding place for germs, and I have had painful evidence of this in some two or three cases.

3. Principles of Rapid Filtration.

The raw water is mixed with a certain percentage of a suitable coagulant in large settling basins. After a period of subsidence varying from six to twelve hours, the water, partially clarified and thoroughly coagulated, is conducted to the top of the filter beds. After filtration it issues as clean limpid water, the remnants of mud and bacteria in it having been deposited on the filter.

The ordinary sand filter depends on an organic growth, which forms on the sand, for the filtering media. It takes about forty-eight hours for this media to form. But, in the case of a rapid filter, the flocculent particles form in a much shorter time a sort of gelatinous coating much tougher than the organic film.

As the preliminary coagulation is of the utmost importance in the operation of a rapid filter, the period of sedimentation and the amount of coagulant required in any particular case should be decided only after carrying out carefully-conducted experiments. For effective filtration, complete clarification is not desirable, as a certain amount of flocculent precipitate is necessary to secure good results.

Every case will need to be carefully considered and the most suitable method employed. The highest efficiency is not always necessary, and considerations of economy may decide a less efficient but cheaper method.

As very high velocities are allowed in these filters, a head of ten to twelve feet is adopted and, in consequence, the sand gets clogged to a considerable

depth. To maintain filtration unimpaired, the sand is washed at intervals by forcing through it a powerful current of water from below.

The time between the two washings is termed a " run," and varies, according to local conditions, from twelve to twenty-four hours.

4. General Arrangement of a Filter Plant.

A complete filter plant consists of—

(1) Coagulating Basin,

(2) The Filter Tanks, and

(3) Clear Water Basin.

The relative arrangement of these should be carefully considered with respect to inspection and control. As the regulation of the coagulant plays a vital part in the action of Rapid Filters, the coagulant appliances and the coagulating basin shauld be located as near the filters as possible. The clear water reservoir may be at some distance. The coagulating basin is usually constructed of masonry with the necessary piping and valves for filling and emptying. The coagulant is made into a solution in large wooden tanks provided with gauges and hard rubber cocks and pipes for regulating the flow. The filter tanks consist of one or more units constructed of wood, steel or masonry, circular or rectangular in form. Within these filter tanks are the sand beds resting on a network of collecting pipes and strainers. The clear water basin is of the ordinary covered masonry type. In many cases, to economise space it is not unusual to place it below the filter tanks, in which case the roof of the tank is made strong enough to carry the weight of the filter beds and the fittings A system of carefully-arranged pipes and valves enables all the operations to be performed from a common platform.

5. Details of Construction.

Some of the important details may be considered now.

1. *Sedimentation.*—In most systems of water supply it is necessary to store the water in artificial reservoirs so as to provide against contingencies. Under such conditions, the water undergoes changes, sometimes for the better and sometimes for the worse.

If water containing a large percentage of suspended matter be stored, sedimentation helps to remove a good portion of such matter, as also living organisms. The colour of the water is also lessened by the action of the sun's rays. Purified water, on the other hand, deteriorates by stagnation and multiplication of bacteria.

The time required for satisfactory sedimentation varies considerably with the nature of the water, and experiments alone can determine the period required in any particular case. It has been known to vary from two or three days to as many weeks. But this period can, however, be considerably shortened by the use of various chemicals, which, when added to the raw water, induce a precipitate somewhat gelatinous in character. This precipitate acts as a coagulant to collect the finely-divided matter into more or less large masses, in which state they can be readily removed by sedimentation and filtration.

Many chemicals have been used as coagulants, but the most commonly used ones are—

(1) Sulphate of alumina.

(2) Ferric hydrate.

(3) Lime.

The choice of a chemical best suited to any particular case will depend upon the constituents of the raw water and upon its cost, economy of operation being a very important factor.

Both at Bethamangala (Kolar Gold Fields) and Bangalore, the coagulant used is sulphate of alumina. When this salt is added to water containng a certain percentage of carbonates, the following reaction takes place :—

$$Al_2 (SO_4)_3 + 3CaCO_3 + 3H_2O = Al_2 (OH)_6 + 3CO_2 + 3CaSO_4$$

The sulphates and the carbonic acid both remain dissolved in the water, while $Al_2 (OH)_6$ is precipitated and forms the coagulum. As the changae that takes place is a definite chemical reaction, it will be advisable to determine accurately by experiment the maximum of sulphate that can combine completely with the carbonates (the quantity of sulphates actually added to the water shnuld be somewbat less than this maximum), as an excess of the former will remain free in the water, a result which it is necessary to avoid. In rare cases where the carbonate present is not sufficient, it may be necessary to add a definite amount of lime to the water.

The amount of coagulant required will depend upon—

(*a*) Turbidity of water,

(*b*) The degree of purification,

(*c*) The time allowed for sedimentation.

As the sedimentation process is only preliminary to final treatment in Sand Bed Filters, it is not usual to aim at a high efficiency. In most works the time allowed for sedimentation ranges from six to twelve hours and the quantity of coagulant from half to three grains per gallon. Of course, if a sufficient quantity of the coagulant be added and enough time be given, a perfectly clear water can be got ; but that is not necessary or even desirable where water is to be purified further in Sand Bed Filters.

In ordinary practice, the water, after sedimentation, may contain about 40 to 50 parts per million of suspended matter, while the number of bacteria would have undergone a reduction of 50 to 60 per cent.

The part played by the coagulant is most clearly described by Mr Robert E. Milligan in a paper contributed to the *Western Society of Engineers*, April 1902 : " The result is the formation of an insoluble gelatinous coagulum of great bulk and relatively greater specific gravity than is possessed by the impurities contained in the water. This coagulum gradually aggregating together, precipitates or subsides throughout the water, enveloping and dragging down such suspended matter and color as it comes into contact with, and after depositing the heaviest portion in the sedimentation tanks finally in a greater or lesser percentage amount, rests upon the filter bed which is interposed between the treated water and the outlet. This coagulum with its entangled suspended matter resting upon the filter bed, offers to the flowing treated water a close and more compact surface than would be offered by the sand grains of which the filter bed is composed."

2. *Filter tanks.*—Gravity filter tanks may be made circular or square in form, and of steel, wood or masonry.

Pressure Filters are generally made in the form of cylindrical vessels of iron or steel. The details vary with each manufacturing company. As a typical example, a description of the Jewell Filter will, perhaps, be interesting.

A Gravity Jewell Filter consists of an outer shell and an inner tank. The inner tank contains the sand and the strainer system. It is generally made five feet nine inches deep and is filled with sand up to a foot from the top. The outer shell envelopes this inner tank, leaving an annular space of six inches all round. This annular space is connected with the drain and the raw water pipes. When the raw water is admitted into this annular space, it rises and flows over the circular rim of the inner tank containing the sand bed and fills it. The raw water then filters through the sand and issues out of the strainer system. During washing, the raw water valve is shut off and the scour valve is opened. The wash-water starting from the strainer system flows upwards through the sand and over the rim of the inner tank into the annular space and out through the

scour pipe. The agitator system is supported on this outer shell and the rakes extended diametrically across the inner shell. In a Pressure Filter there is only a single tank which contains the strainer system at the bottom, the sand on the top of it and a water space on the top of the sand. The raw water pipe is connected with the water space and the effluent with the strainer system. Unlike the Gravity Filters, the strainer pipes are not all connected to one manifold inside the filters. The bottom of the filter is divided into two or three sections and each section has its own strainer system.

The wash-water is admitted by turns into each section with a view to concentrate the flow and help the washing. These filters have no special device for stirring the sand except in the case of very small household ones which are equipped with a hand-operated device.

They are manufactured in sizes varying from 12 to 78 inches in diameter and capable of standing any pressure. In the pumping station of the Bangalore Water Supply there is for the purpose of boiler feed a 48-inch pressure filter which is working satisfactorily under a pressure of nearly 350 feet. At each of the stations of Harihar and Shimoga we have installed two 60-inch pressure filters for the town water supply, and they are giving satisfaction.

During the visit of His Royal Highness the Prince of Wales in 1906 one of these pressure filters was set up on the banks of a jungle stream and supplied filtered water to the Royal Camp at Karapur, and it did good service.

3 *Sand bed.*—The sand should be pure quartz sand. Softer varieties get pulverised and lost during the frequent washings. It should be neither too coarse nor too fine. If the latter, it offers considerable resistance to the passage of wash water and is also liable to be carried away with it, besides getting clogged quickly and thus necessitating frequent washing. On the other hand, if it is coarse, it allows the silt to permeate too deep, which also necessitates frequent washing.

In the Bangalore filters, the depth of sand including gravel is four feet, of which the sand is three feet three inches deep, and the layer supporting the sand, consisting of gravel pebbles one-eighth to one-fourth inch diameter, nine inches thick.

Much pains were taken in getting the proper sand, and sieves of 20 and 40 meshes to the square inch were used to reject the coarser and finer particles respectively. The process was rather laborious and costly, and the cost of a cubic yard of sand amounted to Rs. 11 in Bangalore. Each filter required 27 cubic yards of sand to fill it.

4. *The strainer system.*—A well-designed strainer system is of the utmost importance in the case of rapid filters. It has a double function to perform. The first is to collect the filtered water and the second is to distribute the wash-water. The first function is simple and it will suffice if the strainers are so spaced that the "loss of head" is uniform over the whole area, and the size of the holes in the strainers made sufficiently fine to keep out the sand. As regards the second function, there are two sources of resistance to the passage of wash-water; and these are—

(1) friction through the sand, and

(2) friction through the strainer system.

To ensure equal distribution of the wash-water it is essential that the resistance encountered by it should be fairly uniform over the entire area of the filter. But item No. 1, "friction through the sand," varies, owing to the sand being more clogged in some places than in others. The essential condition of uniform resistance is therefore secured by making item No. 2 very much larger than item No. 1. By making the holes in the strainers very small, about $\frac{3}{32}$ inches in diameter, the pressure required to force the wash-water through these small holes is made considerable. In this way any slight local variation in the sand friction does not materially alter the sum total resistance in any one spot. The head required to overcome the combined resistance is generally 40 feet.

The strainer system itself consists of a net work of well-arranged drain pipes discharging into a centrally located manifold. Into these drain pipes are screwed the strainer heads. A 17"-diameter gravity filter contains about 930 of these.

In some cases, a system of concrete drains covered over with suitable perforated bronze plates have been substituted in place of the pipe system.

5. *The agitator.*—This is an important adjunct in all Rapid Filters. It is essential that the sand should be capable of being thoroughly cleaned on an average once every twenty-four hours. The cleansing itself is done by forcing a liberal volume of water under pressure through the manifold system. To assist the water it is usual to employ some mechanical means to stir the sand, either compressed air or a mechanical agitator. When the former method is used, air under a pressure of 3 to 5 lbs. per square inch is pumped along with the water.

In the second method, a system of rakes, reaching almost to the very bottom and permanently fitted in each filter, is made to revolve while washing is in progress. Provision is also made for reversing the direction or rotation. The mechanism is operated by means of belting from a common shafting and it takes 6 h.p. to work it.

It may be interesting to know that, after washing, the rakes are withdrawn by reversing the agitator. The rakes then assume a slanting position and lie almost on the surface. The object of this is to prevent water creeping past them without undergoing proper filtration. Which of the two systems is best adapted depends upon local circumstances. As regards their relative merits, opinions differ. Personally, the writer prefers the rakes, although he has no experience of the other system.

6. *Washing system.*—As already explained, the wash-water is supplied through the Manifold system. For this purpose suitable pipe connections are provided, whereby the outlet is closed and connection established with the wash-water main. As the water flows upwards through the filter bed, the sand is washed and the mud and other impurities are carried with it into the scour pipe.

The wash-water, which, by the way, is also filtered, is supplied under a pressure of 40 feet. Its volume has an important bearing on the proper cleansing of the sand. About 3 to 5 per cent of the total yield from a filter may be taken as the supply required for this purpose. A 17-feet gravity filter requires about 1,400 gallons per minute. The time occupied for a wash varies from 10 to 15 minutes. In some cases the water is pumped through at this rate by special pumps and in others it is supplied by gravitation from an elevated tank.

7. *Re-wash.*—After a filter is washed, the filtrate is generally not satisfactory for the first 10 or 15 minutes till a proper filtering skin is formed. It is therefore customary to waste it during this period. Suitably-devised pipe connections and valves enable this being done. This process is sometimes called "Re-wash."

8. *Rate of filtration.*—The rate of filtration is 125 million gallons per acre per day. To work at this rate, it requires about 3 to 4 feet head when the filter is clean. But, as the sand gets clogged, this head is automatically increased to maintain a constant rate of filtration. A maximum head of 12 feet is adopted as one giving satisfactory results.

Each filter is provided with a device for automatically controlling the head and thereby the rate of filtration. There is also a device for maintaining a constant level of water on the top of the filter bed.

In the Jewell Filter Plant, the rate of filtration is kept constant by a controller, which is the invention of Mr. Weston, the Consulting Engineer, Jewell Filter Co. A detailed description of Mr. Weston's controller is to be found in the *Engineering Record*, November 25, 1889. It is ingenious and thoroughly reliable.

The Company claim for this device that, besides maintaining the rate constant, it exerts a sucking action by creating a negative head below the filter bed. This has the effect of removing all air bubbles from among the sand

particles and thereby compressing it and preventing the suspended matter from penetrating deep into the sand. It is also stated that this feature is not to be found in any of the other systems.

9. *The piping system.*—A speciality of these filters is a very complete and carefully-arranged system of pipes and valves.

A convenient arrangement often adopted is to range the filters in batteries of single or double rows, and to lay between them the three main pipes, namely,—

1. Raw water pipe,
2. Scour or waste pipe, and
3. The wash-water pipe.

For compactness the pipes are laid one on the top of the other.

Branches from these mains controlled by suitable valves are provided for each filter. The various valves can be operated from a platform above. Every filter is provided with stop-valves for controlling the following pipes:—

1. The effluent pipe.
2. The re-wash pipe.
3. The wash pipe.
4. The raw water pipe.
5. The scour pipe.

The filter water is discharged by the controllers into a separate main or masonry duct.

10. *Miscellaneous.*—Besides the appliances enumerated above, every filter is equipped with a water gauge and a gauge to indicate the head under which the filter is working. This latter gauge is sometimes called " the loss of head gauge." The operators watch this gauge and commence washing the filter when it registers 12 feet, the maximum head allowed. In some very elaborate plants provision is made to operate the various valves hydraulically from a central table. A bacteriological laboratory is also provided.

Rapid Filters in Mysore.

The first Rapid Filter to be erected in India was one installed by the Mysore Government at Bethamangala for the water supply to Kolar Gold Fields in the year 1903. Since then the system has been adopted for other towns in the province, *viz.*, Bangalore, Harihar, and Shimoga. Jewell Filters for the town of Mysore have just been sanctioned, and schemes for the towns of Davangere and Nanjangud are in contemplation.

Jewell Filters at Bethamangala.—The water supply to Kolar Gold Fields is derived from a tank at Bethamangala, which is at a distance of seven miles from the fields. The complete project cost Rs. 12,45,098.

A system of four masonry gravity type of Jewell Filters, each 17 feet diameter, is employed for filtering the water. The capacity of the plant is two million gallons in 24 hours. The raw water from the tank is raised by means of centrifugal pumps to an over-ground subsidence basin. After sedimentation in that basin for six hours the coagulated water flows on the top of the filters; from whence it is collected in an under-ground pure water tank, to be pumped ultimately by means of powerful pumps to the Gold Fields against a head of very nearly 500 feet.

The approximate cost of the filters, subsidence basin, building and pure water tank only amounted to Rs. 1,58,517. About 40 tons of sulphate of alumina costing Rs. 4,000 are consumed annually at this station. The project has paid up to date Rs. 14,35,044 in the shape of revenue, excluding the yearly maintenance charge.

Jewell Filters in Bangalore.—Subsequent to the erection of the plant at Bethamangala, the old sand-bed filters of the City of Bangalore were also converted into the Jewell System, as these filters totally failed to supply clear water to the town for eight months in the year when the water in the lake became turbid.

The system consists of two settling tanks and six filters constructed of reinforced concrete. The pure water tank is situated below the filters. This construction was adopted in consideration of the existing conditions and levels. A water tank built on the top of the tower supplies water for washing purposes. The machinery and pumps are driven by electricity from the Cauvery Power System.

The Bangalore Plant is a Combined System for the City and Civil and Military Station and is capable of supplying three million gallons a day. It cost Rs. 2,29,000, of which one-half was contributed by the Civil and Military Station. This includes establishment on works outlay at 23 per cent. The actual outlay as per accounts is only Rs. 2,12,986.

Recording Venturi Meters register the quantity pumped into the settling basin by the City and Civil and Military Station. After filtration the water is again put back into the respective systems on the basis of the quantity pumped. Under an agreement entered into with the Civil and Military Station authorities the management of the filtering station is in the hands of the Durbar. The total expenditure is shared by the Durbar and the Civil and Military Station in the ratio of their respective input.

Cost of operation.—The annual maintenance cost of the Bangalore Filters comes to Rs. 18,000, excluding the cost of pumping the filtered water to the pure water tanks of the City and Civil and Military Station, respectively.

The quantity of water filtered and supplied per annum amounts to nearly 700 million gallons. The rate per 1,000 gallons for operation works to 5 pies. To this, however, must be added the interest on the outlay and depreciation charges. This may be calculated on a total outlay as under :—

		Rs.
Cost of conversion		2,29,000
Fair cost of the old settling basins, etc., utilised in the new system		71,000
Total ...		3,00,000
Interest on capital outlay of Rs. 3,00,000 at 4 per cent. ...		12,000
Depreciation on Rs. 35,000 (machinery portion of capital outlay) at 5 per cent.	Rs. 1,750	
Depreciation on Rs. 2,65,000 (balance portion of capital outlay) at 2 per cent. ...	,, 5,300	
Total depreciation ...		7,050
Total, including interest ...		19,050

If this be added to the annual maintenance charges, the cost per 1,000 gallons filtered and supplied to the city comes to 9 pies or ¾d.

N.B.—The plant is a three-million gallon plant, but it is not being worked to its full capacity. The rate per 1,000 gallons will be less if the filters are doing their capacity, *viz.*, 1,000 million gallons a year.

Appendix A compares the working cost of the Rapid Filters with the ordinary sand filters so far as the City is concerned. Similar figures for the Civil and Military Station are not available. It will be seen that the extra cost to the City has been Rs. 2,300 per annum, which, considering the marked superiority of the present supply, is very reasonable.

The quantity of alum required to be added to the water varies according to the turbidity. One-fourth grain per gallon suffices when the water is clear and it goes up to three grains when the water becomes turbid. The average for the year works out to ·86 grains per gallon. The price of sulphate of alumina delivered in Bangalore averages Rs. 100 per ton.

In the Bangalore Filters we use, on an average, ten thousand gallons per day for washing each filter. This represents about 2 per cent of the total capacity. No doubt a large quantity of water is used every day for washing purposes, but on examination it will be found that it does not compare unfavourably with the ordinary slow sand filters, if we take into consideration the loss from evaporation, percolation and other causes incidental to that system.

Appendix B gives the result of actual observation and experiment made on this point previous to the erection of the present Jewell Filters. It will be seen that the results are somewhat in favour of the Jewell Filters.

Jewell Filters at Harihar.—The water supply to the town of Harihar is taken from the Tungabhadra. A pair of 60″-pressure filters are used to filter the supply. The raw water is simply pumped through these at the rate of 6,000 gallons per hour. There is no separate sedimentation tank. This no doubt would have been desirable, but the question of cost precluded its inclusion in the estimate. Beyond filling the alum pot at regular intervals and washing the filters once or twice a day, as the case may be, according to the state of the water in the river, the driver in charge of the pumps does absolutely nothing to the filters. Pressure gauges fixed on the inlets and outlets from the filters show at a glance the head consumed by the filters. He has directions to wash them when the difference amounts to 12 feet. The filters are practically proof against contamination. The cost of the entire installation, including the cost of the engines, pumps, filters, and distribution main and tanks, amounted to Rs. 23,165 only. The installation is capable of supplying sixty-thousand gallons per day of ten hours. The quantity of water supplied to the town is actually 17,500,000 gallons per year and the working expenses amount to Rs. 3,500. Allowing for interest and depreciation, the rate per 1,000 gallons works out at Re. 0-5-5.

The town used to be visited by cholera every year, but since the introduction of water supply it has remained free.

Jewell Filter at Shimoga.—The town of Shimoga is situated on the Tunga and is the headquarters of the district. It contains a population of 6,000.

It is supplied with water from the river by means of a steam pump. The intake is about one mile from the town. The rising main is about one mile long and the distribution is by means of 28 hydrants and four small service reservoirs distributed about the town. Water is pumped direct into the town and these reservoirs. There is no separate system of distribution pipes. When there is no pumping, the reservoirs act as balancing tanks and feed the fountains. The supply is filtered by means of two 60″-pressure filters. Daily 50,000 gallons are filtered and pumped into the city. The cost of the whole installation, including engines, pumps, filters, and distribution, amounted to Rs. 70,152. The working charges amount to Rs. 4,712, of which the cost of alum alone is Rs. 250. Allowing interest on outlay and depreciation, the cost per 1,000 gallons comes to Re. 0-9-7.

The Bethamangala plant, the oldest of all, has been in operation for eight years, and the filters at Bangalore, Harihar, and Shimoga for three, four and two years respectively. They have all been giving satisfaction.

Samples are taken for the purposes of examination regularly every week from the Jewell Filters at Bangalore by the Government Bacteriologist, and the results show that a high standard of efficiency has been maintained. The report of that officer in connection with the official tests of the Jewell Filters at Bethamangala and Bangalore are given in Appendix C of this report and will be found interesting. An extract from the record of the weekly tests for the year 1912, together with a similar extract covering a period of one year immediately preceding the construction of Jewell Filters at Bangalore, is also given in

Appendix D. The unquestionable superiority of the Jewell Filter System is self-evident. The colour of the filtered water has been always very satisfactory in spite of the raw water being very muddy for at least eight months in the year.

The agent of the Jewell Filter Company informed me some time back that the company has been doing very large business of late in India. According to a report furnished by him, the company has already installed 24 gravity plants and a very large number of pressure filters.

We in Bangalore have been thoroughly satisfied with our filters, so much so that an order has been recently placed for four units of 15"-gravity filters for the City of Mysore. The system of rapid filtration is eminently adapted to India, where, on account of the habits of the people, a slow sand filter is never safe, depending as it does on human agency to such a large extent in respect of the periodical cleaning and washing of the sand. Indian waters are in many cases too turbid to yield a satisfactory filtrate by slow sand filtration only. In compactness and ease of operation, the contrast is very marked indeed when one takes into consideration that the slow sand filters cover nearly 50 times as much space as their competitor, the rapid filter, and require nearly 80 to 100 times as much sand. The question of sand alone in many cases may turn the scale in favour of the rapid filter.

The trend of all modern developments is to rely as little as possible on human agency and the elimination of that factor is undoubtedly a step in the right direction; and the writer would therefore strongly urge that wherever a town is contemplating the establishment of a new water supply, the merits of Rapid Filters be carefully investigated and full consideration given to the unquestionable advantages offered by them.

APPENDIX A.

STATEMENT COMPARING SAND FILTERS AND RAPID FILTERS AS REGARDS WORKING EXPENSES.

Cost of filtration by the Old Sand Bed at Yesvantpur :—

Capacity—1,500,000 gallons.

Serial. No.	*Details.*	*Cost.*
		Rs.
I.	Staff including uniform staff ...	1,520
II.	Cost of cleaning and washing materials of one filter every year	2,130
III.	Scraping surface of 3 filters ...	216
IV.	Maintenance of tank, valve, valve house, etc. ...	445
	Total ...	4,311
	Add cost of water for loss from evaporation and cleaning, etc., 41,000 gallons a day at Re. 0-8-0 per 1,000 gallons ...	7,503
	Total ...	11,814

Cost of filtration by the combined Jewell Filters at Yesvantpur for the Civil and Military Station and the City of Bangalore:—

Capacity—3,000,000 gallons.

Serial. No.	*Details.*	*Cost.*
		Rs.
I.	Motor Power and Oil Engine...	5,937
II.	Establishment	3,163
III.	Cost of alum	4,745
IV.	Miscellaneous	3,409
	Total	17,254
	Add cost of water for loss from washing and cleaning, etc., at 60,000 gallons a day at Re. 0-8-0 per 1,000 gallons ...	10,980
	Total ...	28,234
	Portion of cost to be borne by the Durbar ...	14,117

APPENDIX B.

COMPARATIVE STATEMENT SHOWING LOSS OF WATER IN THE OPERATION OF THE ORDINARY SAND AND JEWELL FILTERS RESPECTIVELY.

Capacity of Filters—3 million gallons a day.

	Gallons.
I. Sand Filters—	
Loss from evaporation at ½" per day on filter beds, six filters (3 for City and 3 for Cantonment)...	22,000
Quantity lost in emptying filters for scraping and cleaning once a month at 300,000 gallons for six filters, equivalent per day	60,000
Total loss for City and Cantonment ...	82,000
II. Jewell Filters—	
Six in number at an average of 10,000 gallons each per day ...	60,000
Difference, less, in favour of Jewell Filters	22,000

APPENDIX C.

OFFICIAL TEST OF RAPID FILTERS.

Proceedings of the Government of His Highness the Maharaja of Mysore.

Read Letter No. G., 426, dated the 9th January 1905, from the Senior Surgeon and Sanitary Commissioner [Lieutenant-Colonel Smyth, M.D., I.M.S.,] with the Government of His Highness the Maharaja of Mysore:—

"I have the honour to forward for the information of Government a report sent to me by the Government Bacteriologist, Dr. Sreenivasa Rao, on the working of the Jewell Filter Installation at Bethamangala from a bacteriological view.

2. It will be seen that, so far as the investigation has been carried, the result is altogether satisfactory. The water to be filtered contained a very large number of microbes, rather more than twice the number usually found in the Hesserghatta water; yet the water then filtered contained, when the filter was working properly, far fewer microbes than the Hesserghatta water after filtration by the ordinary method."

Letter No. 257, dated Bangalore, 5th January 1905, from M. Srinivasa Rao, Esq., M.A., M.D., B.Sc., Chemical Examiner and Bacteriologist to the Government of Mysore, Bangalore, to Lieutenant-Colonel Smyth, M.D., I.M.S., Senior Surgeon and Sanitary Commissioner, Bangalore:—

"I have the honour to forward my report on the examination of the Jewell Filters at Bethamangala.

2. The water of the tank at Bethamangala is carried by means of pipes to the pump well from which it is pumped up to the subsidence basin. In its course to the subsidence basin the water becomes mixed with alum in the proportion of one grain to a gallon of water. It takes six hours for water to pass from one end of the subsidence basin to the other, where it is drawn off to the filter beds. During this time, much of the suspended matter and many bacteria are precipitated. The filtering medium consists of six inches of gravel and three feet of fine sand. The filtered water falls into canal line with glazed tiles and is collected in a reservoir from which it is pumped to the Kolar Gold Fields.

3. The first series of experiments began on the 21st December 1904, with the washing of the filtering medium in one of the filter beds by means of rakes worked by engines. This filter bed had been at work the whole of the previous

night. The first and last wash-waters were examined quantitatively and found to contain 9,800 and 150 colonies per c.c., respectively. Immediately after washing, water was let into the filter beds and the filtered water was examined at intervals of five and ten minutes for an hour. The results of the examination are noted below:—

	Number of colonies in 1 c. c.
Water on the filter bed	1,910
Water on starting in filter	1,320
Water 5 minutes afterwards	1,080
Water 10 minutes afterwards	430
Water 15 minutes afterwards	510
Water 20 minutes afterwards	530
Water 25 minutes afterwards	460
Water 30 minutes afterwards	180
Water 40 minutes afterwards	590
Water 50 minutes afterwards	130
Water 60 minutes afterwards	220

As will be seen from the above, the lowest number of bacteria was reached after 50 minutes. The sudden increase of bacteria at the end of 40 minutes may probably be due to an accidental breach in the filtering skin which was apparently re-formed at the end of another ten minutes.

4. After the filter had worked for five hours, the filtering skin on the surface was broken by means of a stick and the filtered water was examieed at once and at intervals of five minutes for half an hour.

The results of the examination are noted below:—

	Colonies in 1 c.c. of water.
At once	160
After 5 minutes	130
After 10 minutes	120
After 15 minutes	150
After 20 minutes	80
After 25 minutes	100
After 30 minutes	150

The above shows the efficiency of the filtering skin in the deeper layers of the sand; for though the surface skin was broken, the variations in number of bacteria are insignificant."

Appendix D.

Results of Quantitative Bacteriological Analysis of Hesserghatta tank water and the filtered water from the Jewell Filter, Bangalore water-supply.

Date.	Tank water.	Present Jewell filtered water.
5-1-1912	220	17
12-1-1912	215	11
20-1-1912	280	9
26-1- 192	180	8

APPENDIX D—*concld.*

Date.	Tank water.	Present Jewell filtered water.	
2-2-1912	100	20	
9-2-1912	415	16	
16-2-1912	210	10	
23-2-1912	500	11	
1-3-1912	235	...	
8-3-1912	560	20	
15-3-1912	350	20	
22-3-1912	360	9	
30-3-1912	145	15	
5.4-1912	190	9	
12-4-1912	175	40	
19-4-1912	460	152	
26-4-1912	575	119	
3-5-1912	342	144	There was a leak in one of the pipes.
10-5-1912	410	175	
17-5-1912	275	176	
24-5-1912	315	43	
31-5-1912	345	16	
7-6-1912	1,045	28	
14-6-1912	1,040	12	
21-6-1912	720	53	
28-6-1912	1,820	28	
12-7-1912	580	20	
26-7-1912	280	24	
19-7-1912	325	64	
2-8-1912	800	13	
9-8-1912	520	4	
16-8-1912	484	24	
22-8-1912	742	31	
30-8-1912	510	9	
6-9-1912	260	12	
13-9-1912	330	13	
20-9-1912	420	12	

Appendix D 2.

Results of Quantitative Bacteriological Analysis of Hesserghatta tank water from the old sand filter—number of bacteria per c. c.

Date.	Tank water.	Present Jewell filtered water.
10-1-1908	1,260	195
17-1-1908	1,960	315
25-1-1908	1,460	285
1-2-1908	1,380	270
7-2-1908	1,260	245
14-2-1908	1,320	325
21-2-1908	1,440	395
29-2-1908	1,620	265
7-3-1908	1,500	364
14-3-1908	1,260	285
21-3-1908	960	265
28-3-1908	1,060	290
3-4-1908	1,280	280
11-4-1908	1,160	215
18-4-1908	1,280	305
28-4-1908	1,440	270
2-5-1908	1,740	390
9-5-1908	2,420	435
16-5-1908	2,680	490
23-5-1908	4,140	770
30-5-1908	5,060	1,335
5-6-1908	3,040	580
21-6-1908	2,460	485
19-6-1908	2,280	395
27-6-1908	2,140	365
4-7-1908	1,980	390
11-7-1908	2,460	820
18-7-1908	2,740	855
24-7-1908	2,260	320
31-7-1908	2,400	360

APPENDIX D. 2—*concld.*

Date.	Tank water.	Present Jewell filtered water.
8-8-1908	2,540	465
15-8-1908	2,620	435
22-8-1908	2,940	480
28-8-1908	2,680	600
4-9-1908	2,640	540
11-9-1908	2,920	565
19-9-1908	2,540	545
3-10-1908	940	350
15-10-1908	920	310
17-10-1908	1,620	350
26-10-1908	1,170	364
3-11-1908	5,180	630
9-11-1908	1,100	610
17-11-1908	2,060	750
30-11-1908	980	490
23-11-1908	840	410
4-12-1908	1,320	840
14-12-1908	1,840	410
23-12-1908	1,940	560
30-12-1908	580	250
6-1-1909	1,400	510
12-1-1909	3,680	1,900
18-1-1909	2,560	490
23-1-1909	5,580	240

A note on the Jewell filter at Naini Tal.

THIS note is divided into seven heads :—

1. A short description of the sources of supply.
2. Reasons why a Jewell filter was installed.
3. The character, chemical and bacteriological analysis of the water.
4. A description of the filter in use.
5. The principle of the filter.
6. The points requiring elucidation.
7. Results of the investigations.

I.—*Sources of supply.*—The source of the water supply of Naini Tal is a number of springs. These are as follows :—

(1) The Bara Nadi springs, situated at the base of Ayarpatta Hill, separated from the Malli Tal bazar by the Bara Nadi. This Bara Nadi is a large nullah which conveys the surface drainage and storm water of a large section of the inhabited area to the lake and receives most of the drainage from the Malli Tal bazar. The springs consists of three main springs referred to in this note as main springs A, B and C : the east spring about 20 yards east of this, the north spring about 15 yards north of the east spring and three springs which discharge into a suction well direct, referred to in this note as the suction well springs A, B and C. The water from the former five springs comes to the surface under covered stone reservoirs from which the water is led by pipes to the suction well, where it joins the water from the three suction well springs.

This is the water which is being filtered in the Jewell filter. It is pumped into a supply tank which holds about 6,000 gallons of water. In this tank it is mixed with sulphate of alum in such a strength that the effluent from the tank contains one grain per gallon of sulphate of alum.

(2) The Cheena, Forest no. I and Forest no. II springs which are situated high up on Cheena Hill.

The water flows by gravitation from these springs and joins the chief distributary mains. These springs are far above the inhabited area.

(3) The Pilgrim spring above Malli Tal bazar on Cheena Hill. This water is collected in a reservoir and distributed to Malli Tal bazar only and never enters the main system. It also supplies water by gravitation to the washout tank for clearing the Jewell filter.

This spring is in the middle of an inhabited area. During the dry season this spring gives very little water and filtered water is pumped up to the Pilgrim reservoir to supply washout water. The Cheena and Forest springs only gives enough water during August and September to supply the whole municipality with water. During the rest of the year the filtered water from the Bara Nadi springs is the main supply of Naini Tal. This water is pumped up to reservoirs on Cheena and Ayarpatta hills from whence it flows by gravitation into the mains.

II.—*Reasons why a Jewell filter was installed.*—Extract from a note on the Jewell filter by Major Robertson, I.M.S.

* * * * * *

Early in May 1909 bacteriological analysis showed B. Coli in the Bara Nadi springs and the water from these was condemned as sewage contaminated and it was decided to purify it by the Jewell method of filtration.

It would appear that it was at once taken for granted that the springs were at fault and no investigation seems to have been undertaken to determine this point or to ascertain whether the contamination was not occurring after discharge of the

water from the springs and during collection. I wished to make this investigation at the time but unfortunately it could not be done.

* * * * * *

In the spring of 1910 the late Colonel Leslie, I.M.S., and Major Robertson inspected the sources of supply. They found considerable quantities of rat faeces on the floor of the collecting chambers and found this infested with frogs. As these were found in all the springs they concluded on general grounds that this was the chief source of contamination and not contamination with human sewage, taking into consideration the site of the springs, their almost constant flow, the chemical analysis of the water, the large and constant contamination with B. Coli and the fact that though the water had been in use for years, no history of any outbreak of disease traceable to it could be found.

The collecting chambers were thoroughly cleaned and rats excluded, the frogs were eradicated in all cases successfully except from the suction well, and despite all efforts to dislodge them they still occasionally appear there.

In spite of these measures the springs still showed occasionally the presence of bile salt bacilli in 1911 and Major Robertson asked me to make a prolonged bacteriological test of the various sources of supply and the efficiency of the Jewell filter to see whether it was suitable to deal with.

Naini Tal water.—This I undertook this year with the help of Captain Wood, R.A.M.C.

III.—*The character, chemical analysis and bacteriological analysis of the raw water.*—Bacteriological tests of the raw water were carried out three or four times weekly between 8th May and 8th August, thus embracing both the dry season and the monsoon period.

The water is a pure clear water having at no period any appreciable turbidity as measured with the platinum wire. It contained however 380,000 fine particles less than 10 μ. in diameter per cubic centimeter and no particles over this size. Ganges water in June before the monsoon is properly established contained as an average of nine tests 256,666 coarse particles and 1,181,111 fine particles per c.c., which was reduced to a very clear water by slow filteration to 40,518 coarse particles and 173,574 fine particles. It will be seen that this water is very clear.

On chemical analysis it gave the following average :—

Total solids 64 parts per 100,000.
Hardness 30 ,, ,, ,,
Free ammonia ·001 parts per 100,000.
Albuminoid ammonia ·001 parts 100,000.
Nitrites Nil.

The chemical composition of the total solids on the 22nd September 1910, when the total solids were 43·6 parts per 100·000 was—

Calcium carbonate 14 parts per 100,000.
Magnesium carbonate 12·3 parts per 100 000.
Sodium sulphate 14·8 parts per 100,000.
Sodium chloride ·4 parts per 100,000.
Oxides of iron and aluminium 2 parts per 100,000.

The alkalinity expressed as calcium carbonate was 22·9.

The total count of organisms that would grow on Agar at 37 c. in 48 hours was made on nine occasions and the average number of bacteria per c. c. that would grow on that medium was 1,816 per c.c.

The water from all the springs was tested on many occasions by seeding it into McConkey's Medium, for bile salt organisms.

The Cheena and Forest springs showed the presence of these organisms occasionally in the dry weather, but after the establishment of the rains they were always negative. The Pilgrim spring was nearly always contaminated showing bile salt organisms in ½ c.c. The position of the spring easily explains this and the fact

that this water was used to wash the filter is a gross defect which has been remedied. Twenty-five tests were made of the water from the five main springs up till 8th July and bile salt bacilli were recovered from A twice, B twice, C once, east once and north eight times. In the latter a large crack was found in the channel and pollution could occur from an adjacent surface drain. This was repaired in August. The suction well showed contamination 13 times. On the 8th July all these springs showed bile salt bacilli and from that time on in 13 tests they were practically always present in the springs and always in the suction well.

The unfiltered water from the top of the filter was tested 36 times and showed bile salt bacilli 27 times. The predominating types of these organisms have been isolated and are given in table VI.

IV.—*Description of the filter in use.*—The filter in Naini Tal is a low type steel Jewell gravity filter, 12 feet in diameter with 5½ depth of sand in it. The water passes through at a rate of 200 gallons per minute. This equals a rate of 210 linear inches per hour, so that the water takes about 19 minutes to get through the filter. After cleaning however we have found that known organisms come through in 4 minutes.

The rate of filtration is based on a rate of 106,624,000 imperial gallons per acre or 120 cubic metres per square metre in 24 hours, which is 2,450 gallons per square foot in 24 hours.

The sulphate of alumina is dissolved in the mixing tank so as to form a saturated solution and from thence is conveyed to a regulating chamber, with a ball cock valve for the purpose of keeping the level constant. Adjacent to this are several vertical pipes with funnel openings placed to receive the coagulant liquid from taps connected with the interior of the chamber. One or more of these taps may be brought into play and in this way it becomes possible to graduate the dose of coagulant. The vertical pipes all lead to a feed pipe through which the liquid is injected into the supply tank fed by unfiltered water. In this supply tank the concentrated alum solution is mixed with the water which is then led on to the top of the filter.

V.—*The principle of the Jewell filter.*—The advantages of the Jewell system are—

(1) Small space occupied by the plant.

(2) Cheapness of working.

(3) Rapidity of filtration.

(4) Rapidity of cleaning.

The principle is to treat the raw water with a harmless salt possessing coagulating powers, such as sulphate of alumina. When this is added the bases of the alkaline constituents of the raw water, e.g. calcium and magnesium unite with the acid in the sulphate of alumina liberating the carbonic acid which was contained in the alkaline bases and setting free the alumina which in the presence of water forms aluminium hydrate. The carbonic acid is absorbed by the water and the aluminium hydrate, which is insoluble, remains to coagulate suspended matter present in the water, i.e. mud, silt, bacteria, &c. The net result is to set free the carbonic acid, reduce the amount of carbonate, increase the amount of sulphate and to precipitate the aluminium hydrate. The reactions are according to the following formula:—

$$Al_2(SO_4)_3 + 3\ Ca\ CO_3 + 3\ H_2O = Al_2(OH)_6 + 3\ CO_2 + 3\ Ca\ SO_4.$$

In order therefore that sufficient aluminium hydrate is formed there must be sufficient Ca CO_3 or Mg CO_3 in the water, i. e., temporary hardness. It would appear therefore that the amount of sulphate of aluminium required to produce a precipitate depends on two factors—

(1) The turbidity of the water.

(2) The alkalinity.

Hazen in discussing the results of Fuller at Lousville in 1896 and other investigations says that "the bacterial efficiency of a filter is not affected by the

number of bacteria in the water provided sufficient alum is added to coagulate the water used," but as bacterial efficiency is percentage reduction, a water with a high bacterial content may not be a potable water after filtration.

The estimation of the turbidity is determined in several ways of which the commonest are—

I.—By the graduated measure rod with a platinum wire 1/25 of an inch in diameter.

II.—By adding 1 per cent. salt to the water and then silver nitrate of known strength till the turbidity produced is equal to the water under examination.

III.—By counting the particles in a haemocytometer cell.

IV.—By the Puech Chabal turbidimeter.

V.—By a standard candle which is placed at a distance of 3 inches below the transparent base of the test cylinder. As much of the sample of water is poured in as is sufficient to cut off the light passing upwards. By experiments with distilled water containing various amount of silica in suspension a scale of turbidity can be determined.

VI.—Mr. Antony's diaphanometer, the turbidity is determined by the use of two Nicol's prisms.

Method no. I.—The standard is taken as one grain per gallon at a point in which the wire is distinct at a depth of 3 feet or the scale of turbidity is that in which the index number 100 is given to a water in which the 1/25 inch platinum wire is visible at a depth of 100 millimetres. Thus—

Depth of wire in millimetres.	Turbidity.
1095 or 43 inches	7
100 or 4 „	100
31 or 1¼ „	500

or if the wire is visible at 1 inch the turbidity is unity, at 2 inches, ·5 &c. In method no. III the particles are divided into coarse and fine. Particles smaller than 10 μ. are classed as fine particles. The number of fine particles present in distilled water and air are estimated and deducted from the total and the turbidity is given in particles per cubic centimetre. The results are compared with method no. I and the turbidity figure calculated accordingly.

For example. It has been found by us that with Ganges water a turbidity of 2, i.e. the platinum wire is visible at ½ an inch equals on the average 20 million coarse and fine particles per c.c., at 6 inches, 1 million, at 48 inches, 170,000.

The Puech Chabal turbidimeter consists of a rectangular tube blackened internally and divided into two equal parts by a longitudinal partition. One end is closed by a plate of ground glass while the other is lengthened out to form an eye-piece.

Within one compartment a closed space is formed next to the ground glass for the reception of the water to be tested. In the second compartment there is a movable screen of ground glass which travels backwards and forwards by means of a longitudinal screw.

The eye sees two screens, one illuminated by light which has traversed the water and the other rays that have passed through an air spacer. The screw adjusts the screen to a position such that the illumination of both screens is equal. The graduation is then read off and is dependent on the law that the intensity of light varies inversely as the square of the distance. According to Hazen with practically clear waters sulphate of aluminium of the ordinary commercial strength, that is to say, with about 17 per cent. soluble oxide of aluminium and 15½ per cent. of alum combined sas ulphate used in quantities as small as 0·3 or 0·4 grains per gallon will produce coagulation.

As the turbidity increases larger amounts are required and the amount of coagulant required is proportional to the turbidity. This amount is approximately 0·02 of a grain for each 0·01 of turbidity. Thus a water having a turbidity of 0·20

requires 0·70 of a grain per gallon, i.e. 0·30 for the clear water and 0·40 for the 0·20 turbidity. These are average minimum results.

As an average it had been found that 2 grains per gallon of sulphate of alumina are required to properly coagulate waters having turbidities of 1·00 for the Jewell filter.

Number of days.		Turbidity.	Bacteria.		Per cent. remaining.	Per cent. removed.	Sulphate of aluminium and in grain per gallon.
			Raw water.	Effluent.			
6	..	0·08	14,087	6,217	44·29	55·71	0·00
5	..	0·07	4,267	680	15·98	84·07	0·24
14	..	0·06	2,613	170	6·50	93·50	0·35
10	..	0·06	2,446	113	4·62	95·38	0·44
9	..	0·11	7,808	284	3·20	96·80	0·55
20	..	0·09	6,979	220	3·15	96·85	0·65
9	..	0·08	5,191	130	2·50	97·50	0·75
16	..	0·12	8,405	242	2·84	97·16	0·83
22	..	0·16	8,506	99	1·16	98·84	0·96
12	..	0·11	11,998	246	2·05	97·95	1·05
14	..	0·16	18,982	423	2·23	97·77	1·16
5	..	0·14	13,981	224	1·60	98·40	1·23
9	..	0·27	19,806	325	1·64	98·04	1·34
14	..	0·27	16,549	324	1·96	99·21	1·45
9	..	0·29	12,194	96	0·79	99·62	1·54
6	..	0·23	13,248	51	0·38	99·09	1·65
7	..	0·58	20,958	220	0·91	97·12	1·72
8	..	0·90	25,958	602	2·88	98·81	1·90
5	..	0·48	21,017	307	1·19	98·91	2·19
4	..	0·84	...	228	1·09	..	3·71

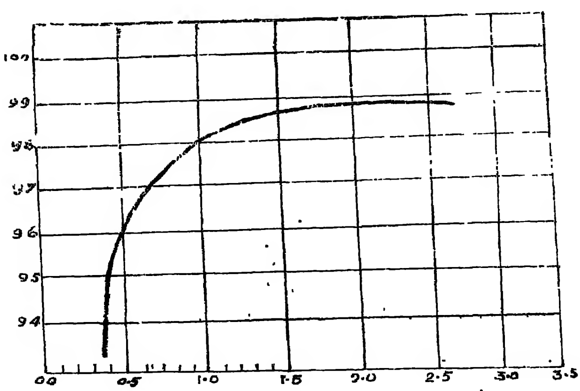
In this table a turbidity of one means that the platinum wire is just visible at 1 inch, ·5 at 2 inches, &c.

The amount of coagulant which can be safely used depends on the alkali of the raw water. There must always be an excess of alkalinity or lime in the water for if not there is nothing to combine with the liberated sulphuric acid.

The amount of lime in the water available to combine with the sulphur can be determined by saturation with a standard acid and a suitable indicator. It is considered prudent to use three-fourths as much sulphate of alumina as corresponds to the lime in the water.

The bacterial efficacy of a mechanical filter is dependent principally on the amount of sulphate of alumina used.

In computing the amount of sulphate of alumina which it would be necessary to use in operating a plant to give bacterial efficiencies, the quantities of alumina as shown by the accompanying diagram can be taken as those which would be necessary to use with clean water (Hazen).



The horizontal figures are the quantities of alum added in grains per gallon. The vertical figures are the bacterial efficiencies. It will be seen that the latter become constant at about 2 grains per gallon.

VI.—*The points that required elucidation* with regard to the Naini Tal water-supply were—

(1) Whether the springs were superficial or deep.

(2) In either case were the springs contaminated by the entry of surface water.

(3) Did the Jewell filter prevent the passage of Coli when 1 grain per gallon of sulphate of aluminia was added.

(4) If it did not prevent this passage how much alumina is needed.

(5) Is the Jewell system suitable for the filtration of clear waters.

In the elucidation of these points the following tests were carried out :—

(I) The estimation of the daily rain fall.

(II) The daily amount of discharge from the combined springs.

(III) The daily temperature of the water.

(IV) The testing for Coli and the total amount of bacteria per c. c. thrice weekly in each of—

(a) The three main springs.

(b) The north spring.

(c) The east spring.

(d) The suction well reservoirs.

(e) The top of the filter.

(f) The filtered water.

(V) Also samples were tested six hours after heavy falls of rain.

(VI) On Sundays samples were taken for bacterial tests half hourly for four hours after cleaning the filter. Also samples were taken every few minutes for half an hour after cleaning the filter in order to ascertain how long it took to establish efficient filtration.

VII.—*Results of the investigations.*—These have been set forth at full length in tables I, II, III, IV, V and VI. We have been led to conclude from these results that—

(I) The springs are deep as rainfall did not seem to affect the flow from the springs until some days had elapsed.

(II) We are however of the opinion that surface water to a certain extent also gets access to the springs as the temperature of the water varied considerably at various periods and the appearance of bile salt bacilli in the water seemed to follow as a rule quickly after heavy rain.

On several occasions we put culture of B. Prodigiosus in holes in the slope above the springs, also fluoresein but could never recover either from the springs.

We are of the opinion that the following improvements should be carried out in order to endeavour to prevent surface water gaining access to the springs :—

(1) The level of the bottom of the suction well is about 5 feet below the level of the Bara Nadi. The well has a sandy bottom and the walls are not impervious. We are of opinion that the water in this well is contaminated from the Bara Nadi which is only a few feet away.

(2) The bottom and sides of the Bara Nadi are lined with stone and the interstices are filled roughly with lime. It should be made watertight for 100 yards and in front of the suction well and springs.

(3) A surface drain which was not watertight runs along the back of the reservoir for the main springs. This was lined with cement in August. It should be kept in good repairs.

(4) The slope at the back of the water works consisting of loose shale was covered with rank vegetation to which both human beings and animals could obtain access. This should be kept absolutely clean and railed in.

(5) Neither the supply tank nor suction well had covers. These have since been supplied.

(6) We are of opinion however that after heavy rain in spite of every care contaminated surface water is liable to gain access to the springs as it has been doing. We are not however of opinion that the water shows constant signs of recent faecal contamination, in fact we consider that if the improvements suggested are carried out, the risk of contamination of the springs from human excretal sources will be infinitesimal.

Table II shows that the filter was having no effect on the bacterial content with one grain per gallon of sulphate of alum added.

(III) A perusal of table III will show the results we obtained by adding 1,000 c. c. of a 48 hours' culture of a known bile salt organism to 6,000 gallons of water containing one grain of sulphate of alum per gallon to the supply tank and running the water through the filter. It will be noticed that the organisms were reduced from 513 per c.c. to 60 per c.c. in half an hour. The filter therefore did not prevent the passage of a Coliform organism but reduced the numbers very considerably. We also tried experiments with M. Prodigiosus, but the strain we used did not assume the characteristic colour very well, so that we could not guarantee the accuracy of our count ; we discarded the results of this experiment.

(IV) The results of our tests with 2 grains per gallon of sulphate of alum is given in tables IV and V. The former gives the reduction of organisms naturally in the water and the latter the reduction on adding 1,000 c.c. of a 48 hours' growth of a known bile salt organism as done previously.

It will be seen from table IV that the filter now stopped a large percentage of organisms in contradistinction to what occurred in the experiments when one grain per gallon of sulphate was used. The filter was working quite efficiently at the end of half an hour.

The figures are the average of several experiments.

In table V we have the results of the tests with the same known Coliform organism as was used in the experiment, the results of which are given in table III. The conditions of the experiment were exactly the same with the difference that 2 grains of sulphate of alum were in the water.

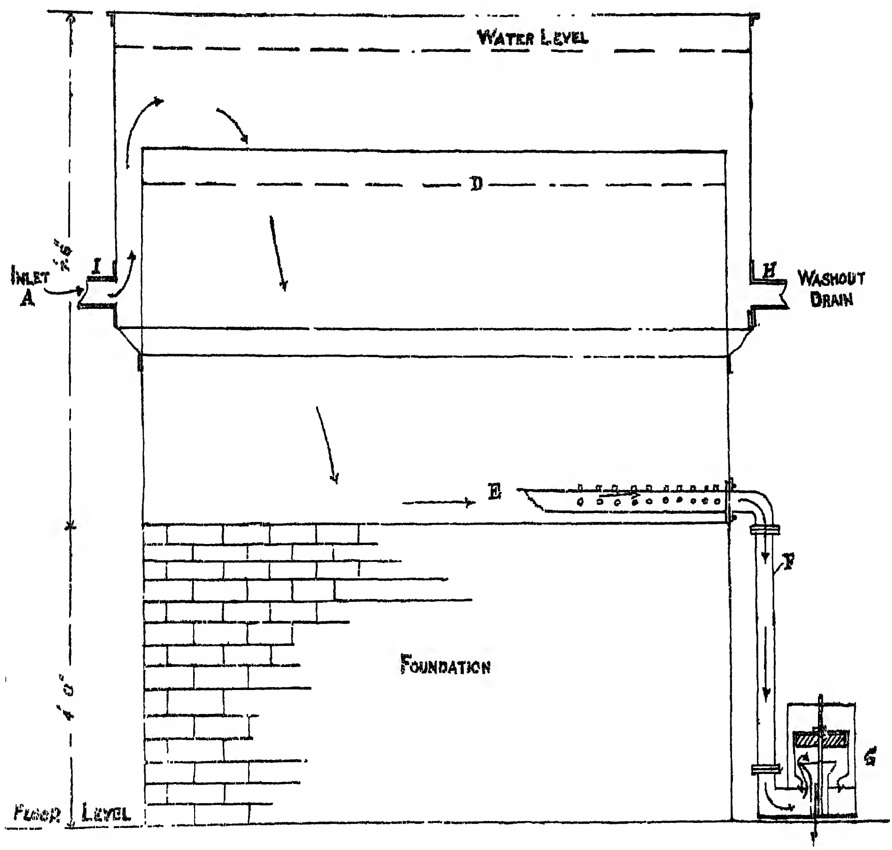
It will be seen that the total reduction in half an hour was 260 and that the percentage reduction was 97·7. The organism did not produce acid and gas in McConkey's medium except with test 7. On subculturing the original organism we found that it had lost the faculty of lactose fermenting which explains this result.

The point established is that the Jewell filter does not stop wholly the passage of B. Coli with 2 grains of sulphate of alum added but causes a large reduction. We did not try any larger quantities than this (cf. chart under paragraph V).

Table VI gives the chief organisms found in the various sources of supply. It will be seen that B. Cloacae is the commonest and that B. Oxytocus Pexniciosus and B. Coli Communis were each recovered once.

With regard to the last point to be elucidated we are of the opinion that the Jewell filter although proved to be excellent for silty river water of high bacterial content it is not an ideal installation for water of the type of that in the Naini Tal springs, which is clear at all times and of low bacterial content but which is nevertheless liable to pollution. In any case the water should be run waste for at least three-quarters of an hour and never less than two grains of sulphate of alum should be added.

JEWELL GRAVITY FILTER



JEWELL EXPORT FILTER CO.
10 CLIVE STREET
CALCUTTA.

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TABLE I.

Showing source of water samples, Bacteriological analysis of same and Meteorological conditions prevailing at the time.

Date.	Rate of flow.	Mean temperature of the water.	Rainfall.	Main Springs. A.	Main Springs. B.	Main Springs. C.	East spring.	North spring.	Suction well springs. A.	Suction well springs. B.	Suction well springs. C.	Forest springs. I.	Forest springs. II.	Cheena springs.	Standpost from Cheena spring	Pilgrim spring.	Standpost from Pilgrim spring.	Pilgrim reservoir.	Wash tank.	Unfiltered water.	Filtered water.	Filtered water reservoir.	Bara Nadi.	Remarks.
May— (concld.).																								
9th ..	110	..		—	—	—	—	—	..	—	..	..	..	..	..	..	..	..	..	+	+	—	..	Rate of flow and mean temperature are those of the main springs and east and north springs combined only.
10th ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
11th ..	110	..		—	—	—	—	—	..	—	..	..	..	..	..	..	..	..	..	+	—	—	..	
12th ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
13th ..	110	..		—	—	—	—	—	..	+	..	..	..	..	..	..	..	..	..	+	+	—	..	
14th ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	A + means bile salt organisms present.
15th ..	110	63·5°	Total rain of May 2·20 inches.	—	+	—	—	—	..	+	..	..	..	..	..	..	..	..	..	—	—	—	..	
16th ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
17th ..	110	67°		..	—	..	—	+	..	+	..	..	..	..	..	..	..	..	..	+	+	—	..	Rate of flow is gallons per minute.
18th ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
19th ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
20th ..	114	..		—	—	—	—	+	..	—	..	..	..	..	..	..	..	..	..	—	+	—	..	
21st ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
22nd ..	114	59°		—	—	—	—	—	..	—	..	..	..	..	..	..	..	..	..	—	—	—	..	
23rd ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
24th ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
25th ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
26th ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
27th ..	120	59°		—	—	—	—	—	..	+	..	..	..	..	..	..	..	..	+	+	—	—	..	
28th ..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
29th ..	120	..		—	—	—	—	—	..	+	..	..	..	..	..	..	..	..	..	..	..	—	..	
30th ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
31st ..	120	..	..	—	—	—	—	—	..	+	..	..	..	..	..	..	..	..	..	—	—	—	..	
June.																								
1st ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
2nd ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
3rd ..	120	..	—	—	—	—	+	—	..	—	..	..	..	..	..	..	..	..	..	—	—	—	+	
4th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
5th ..	118	..	—	—	—	—	—	—	..	—	..	..	..	..	..	..	..	..	..	—	—	—	+	
6th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
7th ..	118	..	·14	+	—	—	—	—	..	—	..	..	..	..	..	..	..	..	..	—	—	—	+	
8th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
9th ..	..	..	·04	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
10th ..	120	..	·02	—	-	—	—	—	..	+	..	..	..	..	..	..	..	..	..	+	+	+	+	
11th ..	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
12th ..	120	..	·26	—	+	—	—	+	..	+	..	..	..	..	..	..	..	..	..	+	+	+	+	
13th ..	..	..	·01	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
14th ..	120	66°	·09	—	—	—	—	—	.	—	..	..	..	..	..	..	..	..	..	+	+	—	+	
15th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
16th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
17th ..	120	66°	—	+	—	—	—	..	+	..	—	..	..	..	..	..	..	..	..	+	—	—	+	
18th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
19th ..	120	62°	·11	—	—	—	—	—	..	—	..	..	..	..	..	..	..	..	..	—	—	—	+	
20th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
21st ..	120	61·5°	272	—	—	—	—	+	..	+	..	..	..	..	..	..	..	..	..	+	—	+	+	
22nd ..	..	..	20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
23rd ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
24th ..	120	..	—	—	—	+	—	—	+	—	—	..	..	..	..	..	..	..	+	+	—	—	..	
25th ..	..	..	·51	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
26th ..	120	..	—	—	—	—	—	+	+	+	+	..	..	..	..	..	..	..	+	+	—	..	..	
27th ..	..	..	25	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
28th ..	120	68·5°	·31	—		—	—	+	+	—	+	..	..	..	..	..	..	..	+	+	—	..	..	
29th ..	..	..	08	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
30th ..	..	..	35	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
July.																								
1st ..	120	62°	·01	—	—	—	—	+	—	—	—	..	..	..	..	..	..	..	+	+	—	..	..	
2nd ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
3rd ..	125	60·5°	·61	—	—	—	—	..	+	—	..	..	..	..	..	..	..	..	+	+	—	..	..	
4th ..	..	..	·81	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
5th ..	125	61°	·65	—	+	—	—		..	..	..	..	..	..	..	..	..	..	+	+	+	..	..	
6th ..	..	..	2·0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
7th ..	..	..	·07	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
8th ..	125	60·5°	·42	+	+	+	+	+	+	+	+	..	..	..	..	..	..	..	+	+	+	..	..	
9th ..	..	..	·03	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
10th ..	125	39·5	—	+	+	—	—	+	+	+	—	..	..	..	..	..	..	..	+	+	+	..	..	
11th ..	..	..	1·0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
12th ..	125	59°	—	—	—	—	—	—		-	+	..	..	..	..	..	..	..	+	+	—	..	..	
13th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	

TABLE I.

Showing source of water samples, Bacteriological analysis of same and Meteorological conditions prevailing at the time.

Date.	Rate of flow.	Mean temperature of the water.	Rainfall.	Main springs.			East spring.	North spring.	Suction well springs.			Forest springs.		Cheena springs.	Standpost from Cheena springs.	Pilgrim spring.	Standpost from Pilgrim spring.	Pilgrim reservoir.	Wash tank.	Unfiltered water.	Filtered water.	Filtered water reservoir.	Bara Nadi.	Remarks.
				A.	B.	C.			A.	B.	C.	I.	II.											
July— (concld.).																								
14th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
15th ..	125	59·5°	—	—	—	—	—	—	—	—	+	..	..	..	..	..	..	..	+	+	+	..	..	
16th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
17th ..	125	62°	·31	+	—	+	+	+	+	—	+	..	..	..	..	..	..	..	+	+	+	..	..	
18th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
19th ..	125	66°	·67	—	—	—	—	+	+	+	+	..	..	..	..	..	..	..	+	+	+	..	..	
20th ..	..	..	8·0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
21st ..	..	..	5·98	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
22nd ..	130	64°	·49	+	+	+	+	+	..	+	..	..	..	..	..	..	..	..	+	+	+	..	..	
23rd ..	..	..	·01	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
24th ..	130	59·5°	·31	+	+	+	+	+	..	+	..	..	..	..	..	..	..	..	+	+	+	..	..	
25th ..	..	..	·41	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
26th ..	130	60°	·46	+	+	+	+	+	..	+	..	..	..	..	..	..	+	..	..	+	+	..	..	
27th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
28th ..	..	..	·02	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
29th ..	..	..	·10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
30th ..	..	..	·03	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
31st ..	130	59·5	·20	..	+	..	+	+	..	+	..	..	..	..	..	..	..	..	..	+	+	..	..	
August.																								
1st ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	From this date springs overflowed. Pumping was stopped and station was supplied by Forest springs, Cheena and Pilgrim spring.
2nd ..	200	59·5°	2·85	..	—	..	—	—	..	+	..	..	..	..	..	..	+	..	..	—	+	..	..	
3rd ..	..	..	·85	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
4th ..	..	..	2·7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
5th ..	..	..	·06	..	+	..	+	+	..	+	..	..	..	..	..	..	+	..	..	+	+	..	..	
6th ..	..	..	—	..	—	..	—	+	..	+	..	+	+	+	+	..	..	+	..	..	..	..	..	
7th ..	..	..	1·0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
8th ..	..	..	·36	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
9th ..	..	..	·06	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
10th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
11th ..	..	..	·20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
12th ..	..	..	·70	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
13th ..	..	..	·65	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
14th ..	..	..	·35	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
15th ..	..	..	2·3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
16th ..	..	..	·72	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
17th ..	..	..	3·22	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
18th ..	..	..	·90	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
19th ..	..	..	·58	..	..	..	..	..	..	..	..	+	+	+	+	+	+	..	..	..	..	..	..	
20th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
21st ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
22nd ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
23rd ..	..	..	·93	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
24th ..	..	..	1·75	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
25th ..	..	..	·80	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
26th ..	..	..	·12	—	—	—	—	—	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
27th ..	..	..	·22	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
28th ..	..	..	.07	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
29th ..	..	..	·75	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
30th ..	..	..	·05	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
31st ..	..	..	1·10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
September.																								
1st ..	..	..	2·88	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
2nd ..	..	..	5·61	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
3rd ..	..	..	·20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
4th ..	..	..	·06	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
5th ..	..	..	·02	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
6th ..	..	..	·46	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
7th ..	..	..	·06	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
8th ..	..	..	4·15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
9th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
10th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
11th ..	..	..	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	

TABLE II.

Showing the results obtained from testing the unfiltered and filtered water at various periods after cleaning the filter for total colonies and the presence or absence of bile salt bacilli in 1 c. c. of water. The total counts are the average of 9 tests.

Hours after cleaning filter.	Total colonies.	Bile salt Bacilli. Serial No. of test. 1	2	3	4	5	6	7	8	9
Raw water.	1,816	+	+	+	+	+	+	+	+	+
1 hour ..	1,860	+	+	+	+	+	+	+	+	+
1½ " ..	1,688	+	+	+	+	—	+	+	+	+
2 hours ..	1,216	+	+	+	+	—	+	—	+	+
2½ " ..	1,457	+	+	+	+	—	+	—	+	+
3 " ..	1,268	+	+	+	+	—	+	—	+	+
3½ " ..	1,589	+	+	+	+	—	+	—	+	+
4 " ..	1,249	+	+	+	+	—	+	—	+	+
4½ " ..	1,773	+	+	+	+	—	+	—	+	+
5 " ..	1,500	+	+	+	+	—	+	—	+	+
5½ " ..	1,350	+	+	+	+	—	+	—	+	+
22 " ..	1,753	+	—	+	+	—	+	—	+	+

A + means acid and gas in 48 hours in McConkey's bile salt lactose peptone broth.

TABLE III.

Source of sample.	Total colonies.	Bile salt organisms. ½ c. c.	1 c. c.	Remarks.
Suction well water running into supply tank.	152*	—	+ in 48 hours.	* Average of three estimations.
Supply tank after addition of "test" organism.	677†	+	+	† Ditto.
Top of filter 5 minutes after starting..	518‡	+	..	‡ Ditto.
Filter effluent 1 minute after starting	100§	—	..	§ Not the test organism.
" 4 " " ..	1,000	+	..	
" 8 " " ..	225	+	..	
" 12 " " ..	150	+	..	
" 14 " " ..	85	+	..	
" 16 " " ..	90	+	..	
" 18 " " ..	55‖	+	..	‖ Agar rather hot.
" 20 " " ..	100	+	..	
" 22 " " ..	70	+	..	
" 24 " " ..	80	+	+	
" 26 " " ..	75	+	..	
" 28 " " ..	50	+	..	
" 30 " " ..	60	..	+¶	¶ Test organism again isolated nearly pure culture. Where in any column there is neither a + or — this test was not done.

TABLE IV.

Total colonies formed at various intervals after cleaning filter using 2 grains per gallon of alum in the water. The results are the average of 4 tests.

Source of sample.	Total colonies.
Top of filter	284
10 minutes after cleaning ..	55
20 " " ..	66
30 " " ..	9
40 " " ..	10
50 " " ..	20
60 " " ..	9
Wash out water used in cleaning.	37

TABLE V.

Serial no.	Source of sample.	Total count on agar.	McConkey.
1	Raw water before adding culture.	78	Growth.
2	Supply tank water after adding culture.	265	,,
3	1 minute after starting filter.	15	*Nil.*
4	3 ditto ..	15	,,
5	5 ditto ..	5	,,
6	7 ditto ..	25	,,
7	9 ditto ..	5	A and G.
8	11 ditto ..	5	*Nil.*
9	13 ditto ..	15	,,
10	15 ditto ..	10	,,
11	17 ditto ..	5	,,
12	19 ditto ..	Not taken	,,
13	21 ditto ..	5	,,
14	23 ditto ..	Not taken	,,
15	25 ditto ..	5	,,
16	27 ditto ..	Not taken	,,
17	29 ditto ..	5	,,
18	Top of filter 5 minutes after starting	80	Growth.
19	Top of filter before starting.	357	,,
20	Water coming through wall above springs.	265	,,

TABLE VI.

Serial number.	Glucose.	Lactose.	Saccharose.	Mannite.	Dulcite.	Adonite.	Indole.	Motility.	Gram.	Litmus, milk	Gelatine.	Morphology.	Name.	Source.
1	+	+	+	+	—	—	—	+	—	+	—	Coliform ..	B. Cloaca ..	Suction well.
2	+	+	+	+	—	—	—	+	—	+	—	,, ..	Ditto ..	Filter effluent.
3	+	+	+	+	—	—	—	+	—	+	—	,, ..	Ditto ..	East spring.
4	+	+	+	+	—	+	—	+	—	+	—	,, ..	102 ..	Wash tank.
5	+	+	+	+	—	—	—	+	—	+	—	,, ..	B. Cloaca ..	Filter effluent.
6	+	+	+	+	—	—	—	+	—	+	—	,, ..	Ditto ..	East spring.
7	+	+	+	+	—	—	—	+	—	+	—	,, ..	Ditto ..	Top of filter.
8	+	+	—	+	+	—	+	+	.	+	—	,, ..	B. Coli Communis.	Wash tank.
9	+	+	+	+	—	—	—	+	—	+	—	,, ..	B. Cloaca ..	East spring.
10	+	—	+	—	—	—	—	+	-	+	—	,, ..	(?) ..	North ,, Wash tank,
11	—	—	—	—	—	—	—	+	—	+	—	Rod terminal spore.	(?) ..	North spring.
12	+	+	—	+	—	—	-	+	+	+	—	Coliform ..	7 ..	Filtered water. 17th July 1912.
13	+	+	+	+	+	+	+	+	—	+	—	,, ..	B. Oxytocus Perniciosus,	Wash tank.
14	+	+	—	+	—	—	—	+	—	+	—	,, ..	7 ..	,,
15	—	—	—	—	—	—	—	—	+	+	—	Large coccus	(?) ...	Top of filter.
16	—	—	—	—	—	—	+	+	—	+	—	Coliform ..	B. Grunthal ..	North spring.
17	+	+	+	+		—	—	+	—	+	—	,, ..	B. Cloaca ..	East ,,
18	+	+	+	+	—	—	—	+	—	+	—	,, ..	Ditto ..	Suction well.
19	+	+	—	—	—	—	—	+	—	+	—	,, ..	7 (?) ..	Filtered water.
20								+	+	+	—	Rod terminal spore.	Mesentericus ..	

+ Means Acid and Gas in the Sugar Media, Acid and clot in the Litmus milk in 10 days and liquefies Gelatine. Nos. 1, 2, 3, 5, 6, 7, 9, 17 and 18 are identical as are 12 and 14, the others are distinct organisms.

The organisms are placed according to McConkey's list.

INFILTRATION GALLERIES.

MADRAS PRESIDENCY.

A description of these galleries has already been given by Mr. Hutton in his paper read at the All India Conference held in Bombay on 13th and 14th November 1911—*vide* paragraphs 20 to 28 of his paper. A description of such galleries may also be found in Mr. Jones' paper "Water-works of the Madras Presidency" Proceedings of Institute of Civil Engineers, Volume CXXXVII. A model showing the method of filling in an infiltration gallery is also on view at the Conference~~—*vide* also Plan San. No. 75 of 1912.~~

2. There are altogether 10 infiltration galleries in the Madras Presidency and they may be divided into—

I. Shallow infiltration galleries.
II. Shallow infiltration galleries and wells.
III. Submerged infiltration galleries.

The following are the towns which are supplied from infiltration galleries :—

I. Shallow infiltration galleries—
1. Conjeeveram.
2. Cuddapah.
3. Dindigul.
4. Gudiyāttam.
5. Nellore.
6. Guntūr.

II. Shallow infiltration galleries and wells—
1. Tirupati.
2. Trichinopoly.

III. Submerged infiltration galleries—
1. Madura.
2. Tanjore.

3. Owing to the limited time available it is proposed to describe only three typical galleries—

(i) *Cuddapah water-works.*—~~Plans Nos. 69 and 70 of 1912 show the general arrangement of the plant and cross section of the gallery~~. The nature of the soil and sub-soil at site of the gallery are described by Major Drake Brockman, the Executive Engineer who drew up the scheme in his report embodied in G.O. No. 248-M., Financial, dated 6th July 1885, as follows :—

"A source of improved supply, situated about three miles due south of the town, a natural and as experience has proved during the years of greatest drought in the district, an unfailing supply of water of the purest quality, exists in the shape of the so-called 'Bogga' springs. The adjunct spring is superfluous one, for the very name itself signifies in the Telugu language 'a spring' and this in turn gives the name 'Booggeru or the river of springs' to the stream that flows by them and thence in a northerly direction round the town until it joins the Pennar river. It is not difficult to account for these springs which as far as they have been opened up, are six in number for they are located in the left bank of the Booggeru under a high and undulating area of country composed mainly of red alluvial soil and water-worn gravels, superimposed upon a bed of yellowish clay and 'kunkur.' This ground is an excellent filtering medium for the rain water which passing through it

and meeting the impervious clay pan below is tapped by the Booggeru and the sandy bed of which absorbs it and carries it away. Mr. W. King of the Geological Survey of India in his paper contributed to the Cuddapah manual refers to these springs as 'thermal' (and this peculiarity has certainly been observed) and he ascribes their source to a fault occurring between crystalline and quartzite systems of rocks lying within the Cuddapah Govulcherum road, and the Papagni river. Perhaps the tepid nature of the spring water supported this conclusion but I think it right to draw attention to the fact, which a reference to the atlas sheet, will show, that the Booggeru takes its rise at a cataract in the hills above which has worn out at the foot of its fall a deep unfathomable basin of considerable extent and is distant about seven miles from the site of the springs. This basin is always full of water and has doubtless a powerful compensating influence on the water level at the springs themselves. Were Cuddapah a town of sufficient magnitude and importance to warrant the expenditure the fountain head of these springs would ere this have been tapped and the pure supply brought from it by a masonry or other conduit. But taking into account that the whole of the river-bed itself in the proximity of the springs contains a water bearing stratum situated at no great depth below its surface, it appeared to me that not only would it be advisable to take advantage of the chance circumstances of the springs as at present located but also of the whole amount of water that was passing away from them and from above them in the bed of the river itself, by arresting this flow by means of an infiltration gallery constructed in a diagonal direction across the river."

This gallery is the first put down in the Presidency and supplied a town of 18,000 inhabitants for 22 years.

The average rainfall at Cuddapah is distributed as below :—

	Inches.		Inches.
January	0·33	July	3·32
February	0·10	August	5·91
March	0·09	September	6·84
April	0·43	October	5·52
May	1·64	November	3·13
June	2·96	December	0·89

Average for the year, 31·66 inches.

(ii) *Tanjore water-works.*—~~Plans Nos. 71 and 72 of 1912.~~

The nature of soil and gallery are described in Mr. Jones' letter dated 2nd September 1891 as follows :—

" The chief feature of the scheme is the manner of drawing water from the river-bed. The plan proposed is similar to that adopted for the Madura water-works. Both in the Vaigai and the Vennar there is a comparatively small depth of sand overlying the somewhat impervious kunkur. In the Vennar the depth is about 5 feet, and hence an ordinary filtration gallery would not be suitable, as the supply when the water level was much below the top of the sand or river-bed level, would be scanty. Hence a filter bed formed of small tubes or tiles laid in a trench cut right across the Vennar 300 feet long and 50 feet broad has been designed. The filter bed extends from one side of the river and is 50 feet in breadth along the river. The area of $300 \times 50 = 15{,}000$ square feet will, it is believed, give an ample supply to the pumps. This has not been practically tested because it is believed that the experience gained at the Cauvery and Vaigai experiments are a sufficient guide. There is every likelihood of the sand above the kunkur bed in the Vennar containing, or more strictly speaking, carrying more water than the Cauvery, of which it is a branch, because the site is very much lower down the delta and hence the sub-soil flow must be greater, and there are very few occasions when there is no water visible in the bed of the Vennar at the point tapped. There is, therefore, it is believed, every assurance that enough water can be obtained at all times of the year and the reports as to the purity of the supply are no less satisfactory. The Chemical Examiner, whose detailed report will be found in the appendix, says, as the result of an examination of three samples of the water in April last, which samples were taken from wells in the river where the filter bed will be situated 'the water is clear, very slight sediment and in most respects good.' "

The average rainfall at Tanjore is distributed as below :—

	Inches.		Inches.
January	0·88	July	1·76
February	0·53	August	4·45
March	0·33	September	5·7
April	1·20	October	6·39
May	2·20	November	6·44
June	1·62	December	4·61

Average for the year, 36·11 inches.

(iii) *Conjeeveram water-works.*—~~Plans Nos. 73 and 74 of 1912.~~

The nature of soil and the gallery are described in Mr. Jones' letter, dated 6th November 1893, as follows :—

" At the point selected for the site of the headworks the river-bed is 1,000 feet wide, and its sandy-bed, as ascertained by trial pits, is some fifteen feet deep. The summer water level falls as low as eight feet below the surface of the sandy-bed and this, it is believed, is the lowest known summer water level. It was taken when the river was at its lowest in the year 1891. From the subjoined table of rainfall at Conjeeveram it will be seen that the year 1891 had the smallest rainfall of any since 1877 :—

Year.	Yearly rainfall in inches.
1877	38·54
1878	37·76
1879	41·33
1880	40·87
1881	33·80
1882	40·60
1883	39·16
1884	61·48
1885	43·16
1886	43·81
1887	62·47
1888	60·35
1889	37·52
1890	37·23
1891	27·10
1892	39·29
Average	42·79

It may therefore be accepted that the water level is not likely to be lower than when it was at its lowest in 1891, which is seven feet above the hard bed—~~vide plan No. 22~~. Some observations on the sufficiency of water in the Vegavati to meet the town supply have been made in the Assistant Sanitary Engineer's Report above-mentioned. It is not possible to gather any more particulars on this point without expensive experiments as to the yield of water from a trench similar to the one proposed and hereafter to be described. But when it is considered that thousands of acres of land both above and below Conjeeveram are irrigated by spring channels cut from the bed of the river, there is not much doubt but that a sufficient supply of water for the town can be obtained at all times. After careful consideration as to the most suitable plan for collecting the water from the sub-soil it is proposed to do so by laying four lines of open jointed 9″ stoneware pipes in a trench at right angles to the axis of the river and at a depth of seven feet below lowest known water level, this trench commencing from the river-bank where the engine house will be located will extend a distance of 550 feet. The trench will be refilled up with gravel up to the summer water level and above that with river sand. More than one method was designed and actually estimated for, but it was finally decided upon to adopt the above method as being the most economical and most suited to the circumstances of the case. The method of drawing water has been successfully adopted at Cuddapah. It is not suited to any river with a sandy bed which is liable to scouring by high floods. The highest floods in the Vegavati have not been found to exceed 3 feet.

Though the river is 1,000 feet wide at the side of the headworks and has all the appearance of a river draining a very large area of the country, it takes its rise only 9 miles from Conjeeveram. The river is of the nature of a broad sandy belt traversing the valley into which the drainage of the adjoining country flows, but the actual area it has not been possible to ascertain.

It has been said in the previous paragraph that infiltration works can be worked up to a head of three feet. The head is limited solely by consideration of the velocity of the inflow generated by the head. This velocity should be such that the inflowing water should be incapable of carrying sand with it through the openings in the infiltration works.

The area of the openings in the proposed gallery at Conjeeveram is calculated to be 46 square feet. The maximum inflow per minute is to be 1,166 gallons or 186 cubic feet which will require a velocity 0·8 of a foot per second. In some experiments made by Mr. Anderson in connection with his revolving purifiers—*vide* Volume LXXXI, Minutes of Proceedings of the Institute of Civil Engineers he found that a velocity of 4″ per second was incompetent to move any but the finest particles of iron in a vertical tube. In the light of Mr. Anderson's experiments a velocity of 0·8 of a foot per second is too low to cause the finest particles of sand to enter the pipes.

The infiltration pipes will terminate in a manhole near the bank of the river. From the manhole a 18″ cast-iron pipe will convey the water to the suction well. The opening of the inlet pipe into the suction well will be fitted with a sluice gate."

The average rainfall at Conjeeveram is distributed as below :—

	Inches.		Inches.
January	0·52	July	4·40
February	0·39	August	6·27
March	0·14	September	6·17
April	0·77	October	7·45
May	2·26	November	8·72
June	2·71	December	4·32

Average for the year, 44·12 inches.

Appendix I gives the pumping plant used and the details of cost of pumping for the three galleries described in paragraph 3 of this paper.

J. M. LACEY,
Ag. Sanitary Engineer to Government.

APPENDIX No. I.

STATEMENT of pumping particulars for the towns of Cuddapah, Tanjore and Conjeeveram.

Number.	Years.	Population.	Quantity of water pumped.	Consumption per head per diem.	Average working head.	Head for which scheme was designed	Cost of maintenance. Fuel.	Cost of maintenance. Oil and sundries.	Cost of maintenance. Establishment.	Cost of maintenance. Repairs.	Cost of maintenance. Total.	Cost of 1,000,000 gallons raised one foot high.	Type of engine.	Type of boiler.
			GALS.	GALS.	FT.	FT.	RS.	RS.	RS.	RS.	RS.	RS.		
									Cuddapah.					
1	1906-1907 ..	20,000	..	..	..	16	Not available.					Not available.	Single cylinder non-condensing and centrifugal pumps.	Semi-portable multi-tubular.
2	1907-1908 ..	20,000	Not available.	Not available.	Not available.	16	Not available.						Do.	Do.
3	1908-1909 ..	20,000				16	Not available.						Do.	Do.
4	1909-1910 ..	20,000				16	1,261	481	748	996	3,436		Do	Do.
5	1910-1911 ..	20,000				16	1,267	390	769	391	2,817		Do.	Do.
									Tanjore.					
1	1906-1907 ..	57,870	296,711,954	14 0	76 11	108	13,421	1,325	3,392	4,687	22,825	1·01	Worthington, vertical triple expansion surface condensing and pumps.	Babcock and Wilcox patent water-tube.
2	1907-1908 .	57,870	323,570,200	15·3	78·90	108	14,211	1,016	3,493	2,307	21,027	·83	Do.	Do.
3	1908-1909 ..	57,870	314,181,427	14·9	78·00	108	14,488	1,317	3,274	2,356	21,435	·87	Do.	Do.
4	1909-1910 ..	57,870	327,866,479	15·5	73 52	108	14,653	1,129	3,434	3,959	23,175	·96	Do.	Do.
5	1910-1911 ..	60,050	311,734,805	14·2	78·39	108	10,434	1,302	3,321	10,900	26,357	1·07	Do.	Do.
									Conjeeveram.					
1	1906-1907 ..	46,164	184,758,488	10·9	44·69	55	4,191	557	1,271	792	6,811	82	Worthington horizontal compound direct acting, non-condensing and pumps.	Locomotive.
2	1907-1908 ..	46,164	199,173,283	11 8	43·71	55	4,722	761	1,238	1,496	8,212	·94	Do	Do.
3	1908-1909 ..	46,164	220,767,414	13·1	41·41	55	6,503	582	1,317	1,419	9,821	1·07	Do.	Do.
4	1909-1910 ..	46,164	226,847,872	13·4	36 58	55	8,841	761	1,322	2,016	12,940	1·55 *	Do.	Do.
5	1910-1911 ..	53,870	234,128,807	11 9	34·14	55	14,820	698	1,541	2,522	19,576	2·44 *	Do.	Do.
													During the year one Crossley gas engine of 28 B.H.P. one producer and scrubber together with one Hayward Tyler triple plunger pump were installed.	

* The excesses are due to excess cost of fuel and bad repairs of plant and bad local management. The gas engine did not work for a sufficiently long period in 1910-1911 to frame an estimate of the cost of working of this plant.

INFILTRATION GALLERIES.

The type of infiltration gallery preferred in the Madras Presidency was described in the paper read by me at the first Sanitary Conference in Bombay. In order to avoid repetition, it will, I think, suffice if I amplify this paper by a short statement which will, it is hoped, give some useful information to delegates.

Preference for an infiltration gallery.—An infiltration gallery when constructed across the direction of flow of underground water in a river-bed enables us to obtain a much larger amount of water than would be obtained from wells sunk in the river-bed a considerable distance apart. It is thought that wells would require to be put so close as to actually abut each other before such wells could supply an equal amount of water to an infiltration gallery.

This would mean that the infiltration gallery would be cheaper in construction than such wells when placed close together.

If it were proposed to sink wells in a sandy river-bed at a considerable distance apart, say, 300 feet, it would be necessary to connect up these wells either to a common suction pipe or to a common syphon pipe.

These pipes would then be located at a higher level than the bottom level of the wells and at this higher level such pipes would be liable to damage by the scouring action of flood water.

In the Trichinopoly water-works we have an arrangement of three wells joined to a common suction pipe and this pipe has not only been carried away twice in the last nine years, but its presence at a comparatively high level above the bottom of the wells has given us constant anxiety for its safety.

If the wells are not connected to a common suction or syphon pipe at a level higher than the bottom level of the wells, then these wells must be connected by a pipe at a low level usually at the bottom level of a well.

This pipe would usually be of cast-iron owing to the difficulty of jointing stoneware pipes at this depth in the presence of water. If the stoneware pipes were laid unjointed it would be necessary to surround them with broken stone so as to prevent ingress of sand and consequently this would mean the construction of an infiltration gallery. Such a gallery would not require to be supplemented by wells so that under the conditions described it would be preferable, in favourable locations, to adopt an infiltration gallery as the source of supply instead of a scheme of wells.

In the case of the broken stone filling of a gallery I am of opinion that in order to discourage movement of sand surrounding the broken stone it is an improvement to lay this broken stone filling, in decreasing sizes from the stoneware pipe in a similar way to the filling of a sand filter.

This proposal is illustrated in the plan No. 75 accompanying Mr. Lacey's paper.

A well possesses this advantage over an infiltration gallery. Silt in the well or fine sand can be removed by means of a sand pump or a grab dredger.

If silt has to be removed from an infiltration gallery this can only be done by actually removing the broken stone and relaying the same stone, after it has been cleaned.

The silting of an infiltration gallery appears to be due to the presence of fine sand and silt in the river-bed. Where the quantity of this is large as at the Trichinopoly gallery, where it is 12 per cent., the silting of the gallery and also of the wells has been an undoubted fact.

It has been found by mechanical analysis that 12 per cent. of the sand in the river Cauvery at Trichinopoly will pass through a sieve of 100 meshes to the lineal inch, and we look to this reason as the explanation of the indrawing of fine sand with silt into the infiltration gallery and the three wells in the river-bed which comprise the supply works.

In the case of the Conjeeveram gallery the sand at depth is coarse, and there has been no trouble from silting and no reduction in quality of the water since the works were constructed fifteen years ago.

The cost of infiltration galleries constructed in Madras is as follows :—

Table showing the cost per lineal foot, etc., of infiltration galleries.

Place.	Length of gallery.	Depth of gallery below ground.	Depth of gallery below L.W.L.	Expected daily yield.	Estimated cost.	Cost per lineal foot.	Cost per 1,000 gallons.
	FEET.	FEET.	FEET.	GALS.	RS.	RS.	RS.
Conjeeveram	550·0	17·08	7·00	560,000	13,793	25·0	24·6
Gudiyattam	207·0	15·16	8·50	150,000	5,130	24·8	34·2
Nellore	746·0	16·30	10·00	525,000	16,900	22 7	32·2
Trichinopoly	530 0	9·50	7·50	1,320,000	23,250	43·9	17·6
Vizianagram	400·0	26·0	..	750,000	10,300	25·75	13·73
Negapatam	1,200·0	15·0	..	1,233,750	35,080	29·23	28·43

6 | 171·4

Rs. 30·0 say per lineal foot.

MADRAS,
7th November 1912.

W. HUTTON,
Superintending Engineer,
Sanitary Engineer to Government.

PUECH-CHABAL SYSTEM OF WATER FILTRATION

BY

C. H. West, Sanitary Engineer, United Provinces.

This paper is written with special reference to the Puech-Chabal system of filtration which has lately been installed at Cawnpore. The works have just been completed, and the trials are about to be started, so no details of the working of the system can be given as yet.

The trial will last for 12 months, and arrangements have been made for careful analyses to be made during this period. The results which will be available a year hence should prove of interest.

The demand for filtered water at Cawnpore has outstripped the supply and an increase in the supply is imperative. The average daily supply for 1911-12 was 3,900,000 gallons, and the maximum daily average for one month was 4,710,000 gallons. The number of inhabitants drawing water from the mains is 157,000. This gives a maximum daily average of 30 gallons a head for all purposes, manufactures, garden and road watering, and drain flushing.

The supply is to be extended to cantonments and it was decided, that taking into consideration the present and future requirements, the supply should be increased to a maximum of 7 million gallons. This would be 50 p. c. more than the maximum supply for 1911-12. It was also decided to install a district waste meter system to prevent waste.

Up to the present the work of sedimentation and filtration has been done by means of three intermittent type settling tanks measuring 355′ × 255′ each.

The capacity of each tank is 3 million gallons, so the three tanks together contain 9 million gallons or two days' supply during the period of maximum demand. (These tanks have lately had their capacity increased by having their banks raised 2 feet. The figures given refer to the period before they were raised.) There are 7 filters each measuring 200 ft. by 100 ft. The maximum average rate of filtration when 6 filters are in use and one is being scrap ed is a little over 39 gallons a square foot. The numbers of samples of filtered water tested last year were 164, and the average number of bacilli found were 30 per c. c. In only seven samples were the numbers slightly in excess of 100.

Alumino-ferric was used for clarifying the water during the rains, the total amount of the chemical used was 61 tons and the cost about Rs. 5,000. Before 1911-12 alumino-ferric was not used.

When the question of extending the Cawnpore Water Supply came up the alternatives put before the Municipal Board were (*a*) to extend their supply on the same lines as the system they already had : (*b*) to adopt the Puech-Chabal system of filtration and adapt it, so as to make use of their present settling tanks and filters.

We will examine briefly the two alternatives. The first was to extend their system on the exact lines on which they were then working. To provide for 50 per cent more water 50 per cent more settling capacity and an increase of 50 per cent in their filtering area was required. They had 3 settling tanks and 7 filters, the estimate sent in by the Municipal Engineer for extending the supply was for 1 new settling tank and 5 new filters, the details are given below.

5 new filters @ 20,000	... ... =	100,000
One settling tank	... ... =	40,000
Inlets and outlets to filters	... ... =	11,250
Specials to settling tanks	... ... =	5,000
	Total Rs.	1,56,250

There were some other items subsequently added such as Venturi meters which brought this estimate up to Rs. 1,61,250.

The second alternative was an extension on the Puech-Chabal system at a cost of Rs. 1,78,000.

The first estimate could possibly have been reduced as an increase of 50 p.c. in the filtering capacity would have required $3\frac{1}{3}$ new filters say 4 filters and the extra 50 p. c. settling capacity could have been obtained by raising the settling tanks 3 feet, at a small cost. The tanks have been raised 2 feet in connection with the Puech-Chabal system as an extra work and an additional foot would have cost very little. Taking 4 filters at Rs. 22,000 each, the extension would on these lines have cost about a lakh.

The extra work done in connection with Puech-Chabal system is given below:—

One engine house	Rs. 1,740	0	0
Extra work on main structure	" 5,911	0	0
Connections to sand filters	" 13,000	0	0
Total	Rs. 20,651	0	0

The cost of the Puech-Chabal system with the extra work involved may be taken roughly at 2 lakhs against a probable expenditure of 1 lakh for extensions on the old system.

The advantages expected from the Puech-Chabal system are the total saving of money spent on coagulants and a big saving on purchase of sand and sand washing. It is difficult to say what the exact saving will be but it is expected that it will be more than sufficient to cover the interest and sinking fund on a lakh of rupees for a 20 years' loan.

At the time these extensions were under consideration, a reference was made to Messrs. Mansergh & Sons, Consulting Engineers, London, for an opinion as to the suitability of the Puech-Chabal system for the clarification of Ganges water, and an analysis of the water, as it is in the monsoon period, was sent them to judge by. Two members of the firm mentioned visited Paris to inspect the Puech-Chabal system there. They were fortunate in seeing it at work when the Seine was in flood and the water very turbid. They appear to have been quite satisfied with what they saw of the working of the system and gave it as their opinion that the system would be in every way suitable for Cawnpore.

With this opinion and the alternative estimates previously referred to before them, the Municipal Board decided to adopt the Puech-Chabal system for the extensions required.

The attempt to clarify water by means of dual filtration is not new. In many places in England, America and elsewhere preliminary filters of fine gravel or coarse sand have been used for clarifying the water before its arrival at the slow sand filters.

Mr. Armand Puech was however the first to demonstrate how the clarification and purification of water could be carried out in easy stages by passing it through successive layers of gravel graded from coarse to fine before passing it through a coarse sand filter to the fine slow sand filters.

Sedimentation is such a slow process as a rule that any contrivance for hastening it deserves our most careful consideration. In his preliminary treatment of water M. Puech has made an attempt to perfect the slow sand filter so that it may work for prolonged periods without the necessity for cleaning. It is maintained that final filters in a Puech-Chabal system have been found to run for periods of 12 to 28 months without the necessity of cleaning with uniformly good results and the maximum efficiency. The guarantee given the case of the Cawnpore filters states that it will not be found necessary to lay off the slow sand filters for cleaning more than twice in the 12 months. It seems very likely that this guarantee will be easily fulfilled.

It has been questioned whether sedimentation with or without a coagulant followed by preliminary filtration through coarse sand would not give as good results.

To ascertain how far the effluent of the Puech-Chabal system is superior to the method described above, samples of water from sedimentation tanks, with

or without coagulants, and the Puech-Chabal effluents would have to be examined as regards turbidity, chemically, and biologically and at different stages, before and after the water issues from the coarse sand filters and the final effluents from the slow sand filters.

Tests would be necessary to ascertain the quantity of water passed between scrapings through the coarse and fine sand filters. Tests would also be needed to ascertain the effect on pathogenic bacteria, by means of test bacilli artificially introduced. Until we have a series of such tests carried out for the crude river water in different states of turbudity, and carefully note the working expenses, it will be difficult to estimate how far the Puech-Chabal system of filtration is superior to the method described.

The guarantee is given for the working of the Puech-Chabal installation at Cawnpore are detailed below—

(*a*)—The sand filters shall not be required to be laid off for cleaning more than twice in twelve months.

(*b*)—The existing seven filters having a combined area of 140,000 square feet may be worked at a maximum rate of 75 gallons per square foot per 24 hours, without increase in the average numbers of bacteria now shown by periodical analyses.

(*c*)—The average yield of the seven filters in combined working shall not be less than 52 gallons per square foot in 24 hours.

(*d*)—The above results shall be obtained without the use of sulphate of alumina or other chemicals.

Should it be found within a period of 12 months from the date of completion of the work that the guarantees set forth above are not fulfilled by the works covered by the contracts, the contractor shall at his expense execute without delay such additional works as may be necessary in order to fulfil the guarantees.

We have yet to see how far these guarantees are fulfilled and how far the results obtained are superior to the guarantees given.

I will now attempt to describe briefly the nature of the works carried out at Cawnpore and the method in which the filters will be operated. The whole area covered by the filters is 256 feet by 230 feet. The whole area is divided into four main sections consisting of three series of graded gravel strainers or Degrossisseurs and one series of coarse sand preliminary filters or prefilters. Each of these main sections is subdivided into smaller sections. The three series of gravel strainers are each divided into 4 subsections and the prefiltering area is divided into 8 subsections. The arrangements for filling these subsections and drawing off the effluent are such that any one of them can be separately isolated for purposes of cleaning. This gives great elasticity to the system and ensures that no more than a small fraction of the filtering area will be out of action at one time.

Each prefilter will yield as a maximum one million gallons per day of 24 hours so that when all sections are in use the yield would be 8 million gallons but allowing for interruptions for cleaning, the system has been designed for a working capacity of 7 million gallons. In the first series of gravel strainers the gravel is supposed to be of $\frac{3}{4}$ inch size and is 10 inches deep and width of the bed is approximately 12 feet. In the second series, the gravel is $\frac{1}{2}$ inch size and 12 inches deep and the bed width is about 20 feet. In third series the gravel is $\frac{1}{4}$ inch size and 14 inches deep and the bed width is 36 feet. It will be noticed that the bed widths of the three series are as 3 : 5 : 9 and the velocities of flow are in inverse proportion to these widths. As regards the prefilters of coarse sand the velocity is approximately 250 gallons per square foot per day of 24 hours or 20 inches per hour. In the designs of the gravel strainers and prefilters all external and main division walls are of brickwork in lime resting on concrete with the faces plastered. In each of the gravel strainers there are a series of thin dwarf walls running along the length of the beds, sub-dividing the gravel bed into sections. These dwarf walls are about 4 feet apart. Resting on these dwarf walls and raised above the floor are a series of ferro-concrete beams,

about 2 feet from centre to centre, supported by these walls. These beams run across the width of the beds. Supported on these beams are a number of perforated ferro-concrete pipes running longitudinally and parallel to the dwarf walls for cleaning the gravel strainers by compressed air. There are three ferro-concrete pipes in each section of 4 feet between these dwarf walls. Resting on these pipes and partly on the walls are perforated ferro-concrete slabs which form a false bottom over the whole area of the gravel beds and on which the gravel is supported. Above each series of gravel strainers there is a continuous feed channels about 4 feet wide for supplying water to each section in the series, and below each series there is a collecting drain 2' 3" wide in which the water rises and cascades into the feed channel of the next series. These cascades which are between 4 inches and 6 inches in height serve to aerate the water and maintain or increase the amount of dissolved oxygen in it. Below the feed water channels between each set of strainers, and between the last set of strainers and the prefilters sludge drains are provided to carry off the wash water when the strainers are being cleaned. For the aircleaning plant there is provided a 12 B.H.P. Blackstone oil engine with a Roots blower and an elaborate system of cast iron pipes to distribute air to the ferro-concrete pipes mentioned above. The air passes along these cast the iron pipes to the ferro-concrete pipes. Each section of 4 feet being controlled by a separate sluice valve so that the air can be applied exactly where wanted. In working the system the feed water can be admitted either directly from the unfiltered water main into the feed channel of the 1st series of strainers or through the sedimentation tanks.

The level of the water in the sedimentation tanks is 2 feet above the level of the water in the feed water channel for the first series of strainers. This level was taken so as to provide sufficient water to carry on with in case the engines at the unfiltered station were stopped temporarily for any reason.

The water from this feed channel enters the 1st series of strainers. There is a fall of 4 inches between the full supply level in the feed channel and the level of water in the stainers. The water after passing through the gravel bed of the series of strainers through the perforated plates to the chamber below rises up in the collecting drain, below these strainers. The loss of head in passing through this gravel bed at the full velocity is taken as 8 inches, the water then cascades (6 inches) into the feed water channel of the next series of stainers, and after passing through this bed it rises up in the collecting drain below the bed with an estimated loss of head of 8 inches, and again cascades (6 inches) into the third series of strainers and rises up in the collecting drain. The loss of head here has been saken as 10 inches, it then cascades 4 inches into the feed water channel of the coarse sand filters. There is a difference in level of 3 feet 8 inches between the water level of the prefilters and the slow sand filters, so that a maximum loss of head of over 3 feet is available for operating these prefilters.

When any section has to be cleaned, all that is necessary is to shut off the outlet to the collecting drain and open the outlet to the sludge drain, at the same time the water in the filters is lowered and the air blast turned on. The air blast is applied section by section, it loosens the silt and slime round the boulders which is washed away into the sludge drain. The water is at first chocolate coloured and gradually becomes clear. It is stated that about 10 minutes are required to accomplish the washing of one basin and the amount of wash water used is on an average under 1 p. c. for all cleaning purposes. It is estimated that the prefilters will require scraping once in three weeks or a month and the strainers once weekly, but during the rains a daily or two day cleaning of the gravel straioers may be needed. The Puech-Chambal company supply an automatic dredger and scraper for cleaning prefilters but the cost was too high for the Cawnpore Municipality and the prefilters will have to be scraped in the ordinary way by manual labour.

It may be explained that the Puech-Chambal system can be worked without cascades and without the air cleaning arrangements where for any reason it is more convenient to omit these. It will be seen that the design of the installation at Cawnpore is very complete in every way and we have every reason to expect

that the results will be sufficiently good to justify the Municipality in their choice of this system of filtration for increasing their supply.

As stated before the results of the tests will be presented next year and it is therefore not necessary to say more about this at present.

C. H. WEST,

Sanitary Engineer to Government, U. P.

Tube wells as a source of Public Water Supply.

It is unnecessary for me to enter into details of the inadequate and contaminated state of the water supplies of many of the towns and villages in India. Every sanitarian knows the necessity of a pure water supply if the health of the people is to be improved.

In order to provide a supply of good water, the wells require to be situated on land free from surface contamination and therefore at some considerable distance from the village, the water being pumped from the wells and delivered to an elevated tank centrally situated in the village, or to ordinary standposts.

A scheme of this type is somewhat costly, necessitating as it does, wells probably sixty to seventy feet in depth, a length of at least half a mile of delivery pipe from the wells to the village and a higher powered engine to overcome the friction in this half mile of pipe.

For villages or small towns where the subsoil water level is within twenty feet of ground surface, the initial cost of a water scheme of this nature would roughly be Rs. 7 per head of population, and the annual maintenance including depreciation and interest 15·47 annas per head of population. Statement A attached hereto shows how these figures have been arrived at, and although calculated on a supply for a town of 6,000 inhabitants, they are approximately correct for populations between 1,000 and 10,000.

Statement B shows the initial cost of a scheme for supplying this village with the same quantity of water from tube wells ; this comes to Rs. 3 per head of population, showing a reduction of 56 per cent. in favour of the tube well scheme. The annual maintenance amounts to 10 2 annas per head of population, being a saving of 33 per cent. over the supply from ordinary wells.

This difference in initial and recurring cost between the two schemes is due to the fact that one medium sized tube well is capable of supplying all the water required, and it can be sunk in the village below contamination level, affecting a further saving of the half mile of rising main and in the engine power required to overcome the friction in this main.

These savings in initial cost effect the saving of 33 per cent. in annual maintenance as shown in Statement B.

Although the tube wells are estimated to last from fifteen to twenty years, no actual test has been made of their lasting capabilities and therefore depreciation at the rate of 20 per cent. has been allowed on the cost of the tube wells including sinking and necessary masonry work. This permits of the tubes being withdrawn and new ones sunk every five years. It is most unlikely that this sinking fund will require to be utilized, but even if untilized the tube well scheme is still very substantially cheaper both in initial and in recurring cost than the ordinary well supply.

These fignres are I think sufficient justification for the installation of a tube well water supply in these towns and villages where the initial and recurring cost of an ordinary well water supply scheme is prohabitive.

Genarally speaking, tube wells may be successfully adopted in any district in which a supply of water is obtainable from ordinary wells, with an average water bearing subsoil the yield of the tube wells manufacture by the Empire Engineering Co., Ld., Cawnpore, varies from five thousand gallons per hour in the 3½ inch tube, to forty five thousand gallons per honr in the 9 inch size.

The subsoil of the Amritsar District might be described as ideal for tube well experiments, it varies from a fine powdery sand near ground surface to a fairly coarse sand at a depths of 100 to 150 feet. Four different sizes of convoluted tube wells have been thoroughly tested and the safe yield has in every case been considerably in excess of that printed in the price lists, varying from 18 per cent. in the fine sand to 80 per cent. in the coarse sand so that the margin of yield for less favourable subsoils is ample.

Having selected the size of tube well which will safely give the required supply, a boring tube of a few inches greater diameter than the tube well should be sunk in the ground to a minimum depth equal to the length of the straining tube plus ten feet, plus the depth from ground surface to dry weather spring level.

In sandy and clayey soils boring is most expeditiously done with a water jet, or Martin's sludgers, but if a considerable depth of rock or kankar has to be passed through, the ordinary hand boring tools will be found most convenient. For most places in India where tube wells are likely to be employed the water jet system will be found most advantageous, as a twelve inch bore tube can be easily sunk from ten to fifteen feet per day up to depths of 200 feet.

On completion of the boring, the straining tube is lowered into the bore hole and to this is added sufficient plain tube to reach to ground surface. The tube well may then be shrouded if the subsoil requires it, the outer bore tube withdrawn and a pump attached to the plain portion of the tube well.

In cases where the subsoil water is a short distance below ground surface, a centrifugal or reciprocating pump may be placed on ground surface or in a chamber a few feet below ground surface. Where the water level is below the suction action of the ordinary forms of pumps the Ashley tube well pump should be employed, and in order to obtain the full discharge of the tube well the plain tube should be of larger diameter than the straining tube. The Ashley pump can be worked with safety in this tube to depths of several hundreds of feet below ground surface. In single pumping plants of this type a water compensating balance relieves the weight of the pump rods; in the duplex sets the rods of one set are balanced by the rods of the other set.

These pumps possess the advantage of working in the tube well and do not require a chamber or masonry well, the arrangement of valves permits of a free discharge of the full tube capacity and in the event of repairs or inspection of the valves, the entire pump can be withdrawn and replaced in the tube well in a few hours.

Tube wells which are to be worked with the Ashley pump should be carefully shrouded to prevent any powdery sand from reaching the valves.

There are several forms of tube wells on the market, nearly all American inventions, which are designed to exclude sand by the fineness of the perforations in the straining material. All of these may be divided into two classes, single and double tube wells, the single tube consisting of one shell slotted or perforated to allow the percolation of water and exclusion of sand: the double tube consists of an inner tube with large perforations, which supports the outer tube consisting of the straining material.

The single tubes are expensive to manufacture and in order to avoid the blinding effects of adhesion and capillary attraction, the tube has to be very considerably longer than the double form for a given discharge.

The straining material is generally the most expensive item in tube well construction, consisting usually of copper or a copper alloy. For temporary supplies required for two or three years, copper gauze may be employed with advantage, this gives an inexpensive efficient tube well, suitable for experimental purposes, or might with advantage be used in forts in war time, or for general military purposes.

Copper or brass Hollander or copper twill can be obtained in varying degrees of fineness of slot and is composed of a weight of wire estimated to last from ten to fifteen years. One form of tube well invented some ten years ago is wound with

copper or brass wire ; practically any thickness of wire can be used, according to the time the tube is required to last ; the space between each turn of the wire is made fine enough to exclude sand, but the disadvantage found in this form is that only very short spans can be used as the wire is liable to break, and the ends springing loose open up a large inlet for sand. The inflow of sand naturally stops the working of the tube and necessitates its return to the makers for repairs.

The convoluted tube well for India manufactured at Cawnpore, is of the double form. The inner portion of the tube is made from one single steel sheet and is so designed that the entire water way area of the straining material is in operation and is equal to the area of the perforations of the inner tube, thus avoiding change in velocity of the water passing between the two portions of the tube. The straining material is of heavy copper wires or bands held parallel with copper ribbons, this is estimated to last twenty years and is consequently expensive. For general purposes copper Hollander will probably be found to meet all requirements.

The question of the relative cost of tube wells is of no great importance when one considers that from an ordinary masonry well twelve feet in diameter as built for modern water supplies, the average yield is roughly 3,000 gallons per hour and the cost is over £ 200 whereas, at a less cost a tube well can be sunk which will yield 45,000 gallons per hour or fifteen times the supply of an ordinary well and under the same head.

I think it will now be generally admitted that a considerable amount of good can be done by the installation of tube well water supplies for towns and villages of India which are in urgent need of good water.

(Sd.) T. A. MILLER BROWNLIE.

Municipal Press, Amritsar.

STATEMENT A.

Rough estimate of cost of a water supply from ordinary wells for a village of 6000 gallons.

Population 6000 at 15 gallons per head per day = 90,000 gallons to be pumped in 8 hours = 11,250 gallons per hour, say 190 gallons per minute.

Average wells of 12 feet in diameter may be expected to yield 3,000 gallons per hour, therefore 4 wells are required.

Estimate of cost of scheme.

	Rs.
Land for 4 wells and engine house 750' X 150' = say $2\frac{1}{2}$ acres at Rs. 2,000 per acre	5,000
Wells 12 feet diameter 65 feet deep. No. 4 at Rs. 3,500 each ...	14,000
Suction main 8 inches diameter laid and joined complete, 550 feet at Rs. 3-11-0 per foot say	2,000
Rising main 6 inches diameter laid and joined complete 2,640 feet at Rs. 2-6-0 per foot say	6,300
Engine house 20' X 12', plinth say 350 square feet at Rs. 2-4-0 per square feet say	800
Engine and pump to lift 22 feet and force 25 feet, with friction of 13 8 feet in 2,640 feet of rising main, and 3 feet in bends, etc., say 64 feet. H. P. = (190 X 10 X 64) ÷ 33,000 = 3·68 with 0·5 efficiency = 7·36 say 8 B. H. P. No. 2 complete at Rs. 4,000 ...	8,000
Elevated tank centrally situated in villiage with all necessary fittings allow	6,000
Total cost ...	42,100

Maintenance of this scheme.

	Rs.	A.	P.
Oil consumption (8 X 0·75 X 8) ÷ 8 = 6 gallons at $9\frac{1}{2}$ annas ...	3	9	0
Lubricating oil	0	5	6
Waste and sundry small stores	0	3	6
Starting oil	0	2	0
Driver at Rs. 30 per month	1	0	0
Daily running cost ...	5	4	0

Annual maintenance.

	Rs.
Driving cost Rs. 5-4-0 X 365 = 1917 say	1,920
Interest on Rs. 42,100 at 4 per cent.	1,684
Depreciation on Rs. 42,100 at 5 per cent	2,105
Total ...	5,700
Allowing for collection and sundries say	5,800

STATEMENT B.

Rough estimate of cost of a water supply from Tube Wells, for a village of 6000 inhabitants.

Population at 6000 at 15 gallons per head per day = 90,000 gallons, to be pumped in 8 hours = 11,250 gallons per hour, say 190 gallons per minute.

One 5 inch convoluted tube well will deliver 11,250 gallons per hour, but allow for the tubes being in duplicate.

Estimate of cost of scheme.

	Rs.
Land in village for engine house and tube wells allow 40' X 12', or plinth area of 700 square feet	100
Convoluted tube well 5 inches diameter, sunk, complete with masonry chambers, etc., No. 2 at Rs. 1,500	3,000
Suction main and fittings 140 feet at Rs. 3 per foot	420
Rising main and fittings 100 feet at Rs. 2-6-0 per foot say ...	240
Engine house, allow 700 square feet at Rs. 2-4-0 square foot say ...	1,600
Engine and pump to lift 22 feet and force 25 feet with 3 feet friction, total lift = 50 feet H. P. = (190 X 10 X 50) ÷ 33,000 = 2·88, efficiency 0·5 = 5 76 say 6 B. H. P. No. 2 at Rs. 3,500 ...	7,000
Elevated tank, centerally situated in village with all necessary fittings allow	6,000
Total cost ...	18,360

Maintenance of this scheme.

	Rs.	A.	P.
Oil consumption (6 X 0·75 X 8) ÷ 8 = 4·5 gallons at 9½ annas ...	2	10	9
Lubricating oil	0	4	6
Waste and sundry small stores	0	3	3
Starting oil	0	2	0
Driver at Rs. 30 per month	1	0	0
Daily driving cost ...	4	4	6

Annual maintenance.

	Rs.
Driving cost Rs. 4-4-6 X 365 = 1,562 say	1,600
Interest on Rs. 18,360 at 4 per cent. say	734
Depreciation on tubes Rs. 3,000 at 20 per cent.	600
Depreciation on remainder of plant Rs. 15,360 at 5 per cent. ...	768
Total ...	3,702
Allowing for collection and sundries say	3,800

Note by the Sanitary Engineer to the Government of Bombay on artesian and sub-artesian supplies of water in Guzerat.—Bombay Presidency.

Guzerat, the most northerly part of the Bombay Presidency, excluding Sind, comprises the British Districts of Ahmedabad, Kaira, Panch Mahals, Broach and Surat, and the Native States of Cutch, Kathiawar and Baroda and some minor States in the several Agencies. Of this tract, the large area extending from the sandy deserts of Rajputana in the north to the Narbuda river in the south, and from the Arravalli hills in the East to the sea coast in the West, consists, for the most part, of one vast alluvial plain, rich in cultivation and where the country approaches the sea, it turns into a sandy waste with a great depth of brackish soil below the surface.

2. The plains of Guzerat are not lacking in the natural facilities of water. The large rivers of the Narbuda, the Tapti, the Mahi and the Sabarmati and their tributaries, traverse the country from the north and east towards the seaboard. Flowing between high banks and affected by tides the large rivers cannot be utilized for irrigation or water supply ; nor, with the possible exception of a few catchments in the hilly tracts, does the flatness of the country lend itself to the construction of storage tanks on the minor streams Indeed, shallow wells are found in large numbers, particularly in the Kaira and Ahmedabad Districts ; but on account of the precarious and deficient rainfall in recent years, their supply fails when most wanted, and is either liable to be contaminated or becomes brackish. Thus, the fertile plains of Guzerat are not favoured with the surface sources of water supply and we naturally turn to the possible underground sources of supply.

3. The question of using bore-holes for increasing the supply of water in percolation wells in Guzerat has engaged the attention of the Agricultural Department, Bombay, and many shallow bores, varying in depth from 50 to 100 feet, have been already put down. In many instances the underground supply was found to be sweet water, even in cases where the percolation water was saltish. The results of these experiments were so successful that there is now a general demand for these boring operations. The wells in which these bore holes proved a success are structurally similar to the spring-wells in the Gangetic alluvium. The alluvium in Guzerat consists of beds of impervious clay at reasonable depths. The wells are sunk up to the clayey bed and the supply is derived entirely from percolation from the cone of saturation all round The bed of clay does not extend to any great distance laterally ; and the water below the clay bed is under pressure, the extent of which really depends on the depth below the level of saturation of the surrounding ground. When a bore hole is made through this clay into the water bearing strata below, the water which was under pressure rushes into the well through the bore hole, where it rises to the level of saturation of the surrounding area. These spring-wells do not differ much from the ordinary percolation wells except in that the gathering area is largely increased, with a proportionately large and more secure supply.

While the volume of supply in these wells is considerably increased, the quantity of water is not improved in its freedom from impurities and contamination, for the water derived from below the impervious strata is really the ground water with which it is in continuous contact. The only hope of obtaining a potable supply of water in Guzerat is, therefore, to go down considerably deep below ground level, so that water that has no communication with the surface except at the outcrop of the waterbearing strata several miles away from inhabited areas may be made available for use. To ascertain whether such waterbearing strata exist in Guzerat and could be economically tapped, has been the object of the deep boring experiments which the Bombay Government have initiated in the British Districts of that Province.

In this paper I shall briefly note the methods and results of the experiments we have made so far.

GEOLOGY OF GUZERAT.

4. Guzerat has not been systematically surveyed by the Geological Department and little is known of the geological conditions of the province. The possibilities of meeting with deep seated supplies of water if borings are undertaken can only be surmised from a few exposures in quarries and wells and a survey of the rocks and minerals found on the surface. Mr. Griesbach, the late Director of the Geological Survey divides the province into three well defined areas which differ structurally from one another :—

(i) The hilly tracts which include the Mahi Kantha and Panch Mahals.

(ii) Cutch and Kathiawar to the north west of the Gulf of Cambay ; and

(iii) The flat country between the hill tracts drained by the rivers flowing into the Gulf of Cutch and Cambay.

5. The hilly tracts of the Mahi Kantha and Panch Mahals consist chiefly of older rocks, schistose and crystalline, both much disturbed. The principal rocks are granite, gneiss, quartzite, limestones, slates and schists. The great volcanic mass of Pavagarh and a group of semi-metamorphic beds chiefly quartzite or quartzite sandstone known as the Champaner beds, lie in the south-western portion of the Panch Mahals District. These rocks do not, as a rule, contain interspaces of sufficient magnitude for the storage of water and it is unlikely that a search for an artesian supply of water here will prove successful. Of course it may be possible that occasionally a boring may traverse a fissure serving as a trunk channel for water; but chances of meeting with an adequate quantity of water from such sources are rare and of no practical importance.

6. Cutch and Kathiawar are outside the scope of our present inquiry.

7. Of the large alluvial plain of Guzerat very little is known of the rocks underlying the alluvium, though the thickness of the latter is not considerable. It is surmised, however, that the alluvial deposits cover a series of beds of the Cretaceous age consisting of sandstones and shales and overlaid by Tertiary clays and lime stones, the whole resting upon the old Palaeozoic rocks of the Aravali type. The various strata are believed to dip gently under the alluvium. The Alluvium itself consists of fine yellowish brown clays impregnated with kankar resting upon sands and sandy clays with occasional gravels. If this hypothesis is correct, accumulations of large volumes of water can be confidently looked for as the structural conditions are peculiarly favourable for the existence of artesian reservoirs. It is in this area, therefore, that the Government of Bombay have commenced to make experimental deep borings.

PLANTS IN USE.

8. We have at present three steam and two hand drills at work. They are all of the Calyx type. One is an A. B.—1 drill, and its capacity is 4,000 feet commencing with a 14-inch bore, and two are F-1 machines capable of boring 800 feet commencing with an 8-inch bore. The hand drills are not capable of boring more than 250 feet starting with 4 inches. The Davis-Calyx drill is a rotary drill working on much the same principle as the Diamond drill; only, instead of a crown of diamonds for grinding away rock "child shot" is used. One great advantage of the Calyx-machine is that it extracts a complete core of these strata drilled through and affords more accurate information of these strata. Except when the cutting tools are dropped in the hole through carelessness, the machines give very little trouble and with a little training local mechanics will be able to work them satisfactorily. All plants excepting one were obtained from the Ingersoll—Rand Company through the India Office, London. One Sehram-Harker & Co.'s improved combined percussive and rotary drill for boring holes commencing at 12 inches in diameter with percussive tools and afterwards continued with the rotary process either with Adroc Steel Cutters or with chilled shot to a depth of 1,000 feet finishing with a hole 6 inches in diameter has been indented for this year. The relative merits of the two types of machines will be judged later on, after actual working For boring in existing wells two more hand drills of 250 feet capacity have been ordered.

WORK DONE UP TO DATE.

9. The boring work undertaken by us was near Sanand in the Ahmedabad District. Work was commenced on 1st September 1909. A steam driven Davis-Calyx drill of the "F" type was used. The plant was incomplete in many respects as it was not equipped for use in alluvium. The machine had only tools for cutting a 4-inch diameter hole and removing a 3⅛-inch core. It was not possible to drive down a pipe of more than 5-inches. The machine otherwise gave no trouble, but the subordinate establishment in charge had no previous experience of this kind of work and had to be trained. With care and attention this pipe was driven to a depth of 290 feet The boring and lining occupied 94 working days. Brackish water was met with at a depth of 38 feet; but below this an impervious layer of clay mixed with kankar overlying alternate layers of fine sand and clay was met with. The lower waterbearing stratum, consisting of sand mixed with gravel was reached at a depth of 261 feet and the lining was continued in this layer for another 30 feet. The water rose in the bore up to within 21 feet from the surface of the ground. The work could not be continued, as the machine with the equipment it then had was not capable of boring to a greater depth. When the necessary accessories were obtained later on, it was not considered worthwhile continuing the bore, the principal reason for coming to this conclusion being that the diameter of the bore to commence with was small. I wish, however, that a 4-inch pipe had been driven down to a further depth of 200 feet or so. I propose to continue the work at a future date as soon as a suitable plant becomes available.

10. Pumping tests were carried out for 14 days to ascertain the yield of this well. It was found that continuous pumping for 12 hours daily yielded 752,520 gallons of water. For the first four days 3,100 gallons per hour were pumped out, the head of depression being only 4 feet. In the next 10 days the yield was 5,000 gallons per hour, working 12 hours daily, the depression in the water level being 13 feet. The time that was taken for the water to recover its original level was not marked, but the water stood at the same (original) level every morning when the pumping commenced thereby indicating that a large underground reservoir of water existed.

11. The following table shows the result of the chemical analysis of the water:—

QUANTITATIVE.										QUALITATIVE.			
Parts per 100,000.													
	Hardness.				Ammonia.								
Total Solids.	Temporary.	Permanent.	Total.	Chlorine.	Free.	Albuminoid	Oxygen absorbed Permanganate process.	Nitrous Acid.	Nitrates.	Sulphates.	Phosphates.	Iron; poisonous metals, etc.
194	11·06	11·80	22·86	70	·056	·044	·560	230	Absent.	Present.	Absent.	Not present Poisonous metals absent

The Chemical Analyser to Government declared the water as unfit for potable purposes as it shewed high figures for total solids, chlorine and ammonia. The presence of total solids and chlorine may be accounted for, as tertiary strata are known to contain strings and crystals of rock salt within their layers; but the presence of ammonia shewing organic contamination cannot be accounted for without a detailed examination of the catchment area from which

the water is derived. This has not been done as the bore has been abandoned for the present. The water having been pronounced unfit for domestic use, a well round the tube has been built and the water is being utilized for irrigation.

12. The particulars of the strata passed through are given in Appendix I.

BORING AT DHOLKA.

13. With the same machine a bore was put down at Dholka in the Ahmedabad District. Work was commenced on 27th April 1910 and a water-bearing stratum was struck on 9th July at a depth of 124 feet below surface. Percolation water, too brackish to be of use, was met with at a depth of 40 feet. The strata passed through are similar to those at Sanand, *viz.*, alternating layers of clay and sand. Unlike the fine sand that was found in the upper layers of the Sanand bore, the strata of sand passed through at Dholka consisted of coarse sand mixed with gravel but no trace of water was found in them. The layer of clay immediately above the water-bearing sand and gravel was mixed with kankar and calcareous tufa. 5-inch lining pipes were used and water rose in the bore to 23½ feet from ground. Pumping tests made shewed that the bore yielded 5,000 gallons per hour with a depression of water level of 6 inches in 12 hours. A more powerful pump was not available to find the yield with a greater head of depression. If a suitable pump is used, I believe the yield will be something like 8,000 gallons per hour or 80,000 gallons in a working day of 10 hours and the bore water can give a 10 gallon supply to a population of 8,000. As, however, the population at Dholka is 15,000 it is proposed to make another bore of a larger diameter in the vicinity and the effect of deepening the bore to say, 600 feet, on the quality and quantity of water will be ascertained. If there is no improvement in the supply, the inner pipes will be jacked up. The water was analysed chemically and the results are given in the following table:—

QUANTITATIVE.										QUALIATIVE.			
PARTS PER 100,000.													
	Hardness.				Ammonia.								
Total Solids.	Temporary.	Permanent.	Total.	Chlorine.	Free.	Albuminoid.	Oxygen absorbed Permanganate process.	Nitrous Acid.	Nitrous Acid.	Sulphates.	Phosphates.	Iron, Poisonous metals, etc.
94	10·89	10·30	21·19	16	·002	·002	·40	0·23	Absent.	Present.	Present.	Present Absent.

The Chemical Analyser has reported that the water may be used for domestic purposes in the absence of organic contamination, until other sources of supply containing less solids and less chlorine are available. The catchment area from which the supply is probably derived is free from organic contammination and the excessive proportion of solids and chlorine are explained by the fact that Dholka was, at no geologically distant date, below the level of the sea. The presence of magnesium sulphate in large quantities goes to confirm this view. In the opinion of local residents the bore water is the best obtainable in the vicinity and thousands of people have been drinking this water for over a year without any ill effects. The supply may, therefore, be considered potable. When a larger and deeper bore is completed, a distribution system will be carried out and the town will be given a piped supply.

14. The particulars of the strata passed through are given in Appendix II.

VIRAMGAON BORING.

15. At Viramgaon in the Ahmedabad District, the Bombay Baroda and Central India Railway made a boring for obtaining a water supply. The wells in Viramgaon are mostly brackish and the town suffers from a chronic scarcity of potable water. The diameter of the bore is 18 inches at top reduced to 8½ inches at bottom. The bore struck sweet water at 378 feet below surface and water rose up the tubes to above ground level with considerable force. On the main tube being plugged and a 1-inch pipe connection being made, the pressure was found to be 6lbs per square inch corresponding to a head of 14 feet. If a deep well pump is fixed in the tubes, a supply of 12,000 gallons per hour will be obtained.

16. The water is sweet to the taste, but the Chemical Analyser to Government will probably not consider the water as potable on account of excessive figures for chlorine in the analysis ; but as there is no sewage contamination at the source of supply there appears to be no objection to the water being used for domestic purposes. The Railway staff at Viramgaon and certain residents have been using the bore water for more than nine months and no bad effects have been complained of, so far.

The results of the analysis are given in the following table :—

1. Volatile and organic matter Grains per gallon	3·400
2. Silica do. do.	1·600
3. Iron and allumina (oxides)	trace
4. Lime (Ca O)	3·300
5. Magnesia (Mg O)	1·873
6. Carbonic Anhydride (Co 2)	9·856
7. Sulphur do (So 3)	9·125
8. Chlorine	41·300

The work was commenced on 5th December 1909 and water was struck on 27th May 1911.

17. Another boring, about 1½ miles away from the Railway bore is being made by us for the water supply of the town and the work is in progress. The strata passed through are identical with those met with in the Railway bore, the particulars of which are given in Appendix III.

18. This well appears to be truly artesian in principle and has been flowing with undiminished volume for 18 months, unaffected by the local rainfall, shewing that an almost inexhaustible supply of water has been tapped. It is a pity that the boring was stopped at 378 feet. It would have been interesting to know the depth of the tertiary clays and limestones and whether sandstone and other rocks of the cretaceous age underlie these strata. The Government boring which has been commenced with a 10 inch hole will be taken down to the full capacity of the plant in use, *viz.*, 800 feet, and the result is sure to be very interesting, if not encouraging too.

SABARMATI BORING.

19. In the hot season of 1912, the well in the Sabarmati Jail near Ahmedabad ran almost dry. As this well is the only source of water supply to the Jail, it was decided to make a bore in the well. A. G. O. hand drill was used and the bore was commenced with a 4-inch pipe which was driven down to a depth of 88 feet below ground. Inside this a 2½ inch pipe was driven to 160 feet when the water bearing stratum was reached. 6 feet in length of the lowest pipe was perforated

and the total depth to which the pipe was driven is 176 feet. The water rose to 29½ feet from ground and the pumping tests made shewed a yield of about 3,000 gallons per hour. Further pumping tests will be carried out and arrangements will be made to build a water tight well inside the present one so as to exclude the surface percolation and draw only the underground water that flows up into the inner well,

The water has been analysed and found to be not inferior to the water that is supplied to the City of Ahmedabad from wells sunk in the sandy bed of the Sabarmati River.

BORING AT KELVA MAHIM.

20. Kelva Mahim is in the Thana District in the Deccan trap area. An experimental boring was made here with a G. O. Calyx drill, an oil engine being used for working the machinery. The bore was 3 inches in diameter and at 35 feet a fresh water steam was struck. The water flowed over the month of the bore indicating artesian conditions. The bore was deepened to a depth of 220 feet at an average rate of 4 feet per day, but there was no improvement in the water supply. This boring is interesting as shewing the existence of large amygdaloid cavities and fissures in the Deccan trap and so placed as to form artesian reservoirs. The capabilities of the Deccan trap as a water bearing rock have not, to my knowledge been systematically tested and the ease with which a small Calyx machine can be used for drilling in such rocks has encouraged me to attempt similar experiments in the Deccan. The yield from the Kelva Mahim bore is about 1,500 gallons per hour. It is proposed to make three other borings 35 feet deep close to the existing one and to enlarge the percolation area by blasting. If the yield of the enlarged well is increased and the pumping tests give satisfactory results the water will be pumped up to an elevated reservoir for distribution in the town.

KHARAGHODA BORING.

21. The result of the Viramgaon boring was so encouraging that it was hoped that a similar underground supply would be tapped at Kharaghoda which is 21 miles N. W. W. of Viramgaon. There are no sweet water wells at Kharaghoda and the difficulty of supplying potable water to the labourers and the establishment on the Government salt works was so great, this year, that it was decided to put down a bore at once. A steam power " F " plant was sent and a boring 8 inches in diameter was started in January 1912 The water available for feeding the boilers was so brackish that the trouble from incrustation delayed the progress of the work. The 8-inch outer pipe was driven down to a depth of 200 feet and a 6-inch bore was started inside it. Except in the upper 30 feet where sand was met with, the boring is entirely through grey and yellow clays. Water was struck at 248 feet on 8th May 1912. As it was not expected that water would be found at this small depth, no perforated pipes were used. Water commenced to flow over the top of the 6 inch pipe at 8 a.m., but the discharge was very small. At 1 p. m. large quantities of sand and clay, the latter weighing about 5 lbs. each, were thrown up, the flow of water gradually increased in volume until on the same evening the discharge was found to be 500 gallons per minute. The pressure under which water was being delivered corresponded to a head of 58 feet. It was thought that, when a large cavity was formed below the lower end of the drive pipe, sand and clay would cease to be brought up to the surface; but unfortunately the pipe got gradually choked up and the discharge was reduced. On the 17th May, *i.e.*, 7 days after artesian conditions had been fully established the discharge was found to be 250 gallons per minute, but the pressure was found to be sensibly the same as before, thereby indicating that the discharge was diminished on account of the reduction in the effective area of the bore pipe and not on account of any change in the artesian conditions. Two days after this the 6-inch tube was completely choked up to within 170 feet from the surface. Attempts were made to remove

the sand and clay, but the pressure was so great that the boring tool itself got caught in the matrix and all attempts to release it proved useless. In spite of the choking up of the tube some water still found its way and trickled over the top end of the tube. here was no alternative but to jack up the inner tube, and while this was done the outer pipe came up with the inner one and both pipes had to be pulled out. As no use could be found for the discharge that would be obtained through a 6-inch bore it was decided to replace it with a 4-inch one and the lowest 40 feet were perforated to reduce the trouble from the blowing up of sand and clay. The 4-inch pipe has now been driven to a depth of 200 feet and it is hoped that the work will be completed in a fortnight.

22. The particulars of the strata passed through in this boring are given in Appendix IV.

23. The bore water was not sent for analysis as it was intended to do this after the establishment of normal conditions of flow without any mixture of sand and clay. But the European officers at the station who used the water for a few days are unanimously of opinion that the water was sweet and the best that they had in the vicinity of Kharaghoda.

24. An interesting question in connection with this boring is why the tube got clogged up and what should be done in similar cases in future. In my opinion the gradual reduction of the discharge without a sensible diminution of pressure may be explained by a partial blocking up of the tube with a mixture of clay, sand and kankar from the moment the artesian condition were established. When it flowed again the flow gradually diminished. If the flow had been properly controlled from the beginning, this mishap would have been prevented. A discharge of 500 gallons per minute through a 6-inch bore is equivalent to a velocity of $6\frac{2}{3}$ feet per second. Such a velocity scours away the hardest clay. The strata near the bottom end of the bore pipe consisted of clay mixed with kankar nodules and sand, and it is not surprising that these were eroded away and blown up the tube. It appears to me that if the velocity had been less so as to be a trifle more than the critical velocity for the water bearing stratum and the layer immediately above it, say about 3 feet per second, the clay and sand would have been brought up gradually in very small quantities and a large cavity would have been eventually formed at the bottom. In the course of a certain period this cavity would have been so enlarged that the area of its internal surface would have allowed water to percolate through at a rate which would not have disturbed the material.

BROACH BORING.

25 A boring is being made at Broach with an A B. machine of 4,000 feet capacity, and commenced with a hole 14 inches in diameter. It is intended to go down until the cretaceous rock is pierced through. An expert of the Geological Department who inspected the locality, has expressed his opinion that a fairly good artesian or sub-artesian supply may be found at a depth of about 2,000 feet. This supply, if obtained, will be utilized for the water supply of Broach city. The work done up to date is given in Appendix VI.

CONCLUSION.

26. It is too premature to claim that the knowledge gained by the experiments carried out, so far, in Guzerat warrants us in forming a conclusive opinion that an unfailing supply of potable water under ground can be relied upon. However, the results achieved point to a reasonable presumption that there is a large volume of fairly good water stored up in the tertiary clays at a depth of about 300 feet, and that the experiments may be carried further to ascertain whether a more reliable and better supply may not be assured when a greater depth is reached and the nature of the strata underlying the clays has been thoroughly investigated and mapped out.

N. BELVADI.

APPENDIX I.

Record of the Sanand boring.

Number of stratum.	Thickness of stratum.	Depth below ground level.	Description of strata.
1	4	4	Black Soil.
2	21	25	Fine yellow clay.
3	13	38	Fine Sand. Brackish water.
4	190	228	Clay with nodules of kankar.
5	7	235	Fine Sand.
6	25	260	Clay with nodules of kankar.
7	44	304	Sand mixed with gravel, water bearing Stratum.

R. L. of ground ... ... + 137·00 (M. S. L.)
R. L. of brackish water ... ... + 99 00.
R. L. of top of impervious stratum ... ... — 98·00.
R. L. of bottom of do. ... ... — 123·00.
R. L. of bottom of lining pipe ... ... — 153·00.

APPENDIX II.

Record of the Dholka boring.

Number of stratum.	Thickness of stratum.	Depth below ground level.	Description of strata.
1	6	6	Made ground.
2	15	21	Black clay with kankar.
3	10	31	Grey clay and murum.
4	9	40	Brown clay and kankar. Salt water level.
5	10	50	Do. with coarse sand.
6	8	58	Coarse sand and clay.
7	21	79	Coarse gravel and sand.
8	1	80	Brown clay and kankar.
9	40	120	Clay with nodules of kankar.
10	1	121	Coarse with gravel.
11	3	124	Calcareous grit.
12	13	137	Fine sand.

R. L. of ground ... ... + 74·00 (M. S. L.)
R. L. of brackish water ... ... + 34 00.
R. L. of bottom of impervious stratum ... ... — 50·00.
R. L. of bottom of lining pipe ... ... — 56·00.
Present water level in bore ... ... + 43·50.

APPENDIX III.

Record of the Viramgaon boring.

Number of stratum.	Thickness of stratum.	Depth below ground level.	Description of strata.
1	2	2	Made ground.
2	12	14	Black soil.
3	42	56	Sand.
4	200	256	Clay mixed with sand.
5	75	331	Clay mixed with sand.
6	27	358	Clay mixed with kankar.
7	20	378	Sand.

R. L of ground ... ... + 88·00 (M. S. L.)
R. L. of existing water level ... . +100·000.
R. L. of impervious strata ... ... −270·000.

APPENDIX IV.

Record of the Sabarmati boring.

Number of stratum.	Thickness of stratum.	Depth below ground level	Description of strata.
1	40	40	Brick lined well.
2	16	56	Sand.
3	9	65	Yellow clay with large nodules of kankar.
4	23	88	Reddish clay with large nodules of kankar.
5	12	100	Kankar.
6	60	160	Yellow clay mixed with murum.
7	12	172	Fine sand.
8	4	176	Coarse sand.

R. L. of ground ... ... + 179·49 (M. S. L.)
R. L. of top drive pipe ... ... + 150·82.
R. L. of top of water in drive pipe ... ... + 149·20.
R. L. of top of water in well ... ... + 149·86.
R. L. of impervious strata ... ... + 19·49.
R. L. of water bearing strata ... ... + 3·49.

APPENDIX V.

Record of the Kharaghoda Boring.

Number of stratum.	Thickness of stratum.	Depth below ground level.	Description. of strata.
1	4	4	Black soil.
2	7	10	Loamy soil mixed with kankar.
3	10	20	Sandy loan.
4	10	30	Coarse sand.
5	66	96	Stiff yellow clay.
6	12	108	Stiff clay grey.
7	85	196	Stiff yellow clay.
8	4	200	Stiff clay mixed with kankar.
9	44	244	Stiff yellow clay.
10	12	256	Fine sand.

R. L. of ground ... ... + 36·04 (M. S. L.)
R. L. of bottom of impervious strata ... ... — 208·00,
R. L. of top of water ... ... + 94·00.

APPENDIX VI.

Record of the Broach Boring.

Number of stratum.	Thickness of stratum.	Depth below ground level.	Description of strata.
1	90	20	Yellow clay.
2	2	92	Shingle and gravel.
3	102	102	Ordinary river sand.
4	2	104	Shingle and small boulders.
5	56	160	Yellow clay.
6	10	170	Sand, lower water level.
7	23	193	Gravel and shingle.
8	2	195	Sand stone and pieces of trap stone.
9	45	240	Quick sand mixed with shingle.

355DE—2,030—17-1-13—GCBP—Simla.

PART III.

WATER-SUPPLY AND DRAINAGE SCHEMES.

476DE

Water-supply and drainage.—

Supply of information regarding the financial position of the—schemes maintained by the municipalities in the Bombay Presidency and the method of taxation proposed to be adopted in financing them.

No. 4202.

GENERAL DEPARTMENT.

Bombay Castle, 2nd July 1912.

Letter from the Secretary, Sanitary Board, Bombay Presidency, No. 2856, dated the 4th October 1911 :—

" I am directed by the President and Members of the Sanitary Board to submit, for the consideration and orders of Government, the following representation regarding the financial position of water and drainage schemes maintained by municipalities in this Presidency.

" 2. As Government are aware, during the last few years the growing demand for modern water and drainage installations, which is due to the spread of enlightenment regarding the advantages of sanitation, has led to a large number of projects, either for new works, or for the extension of existing works, being put forward; and it seems very probable that this demand will increase rather than diminish in the future, more especially if the liberal policy of assistance adumbrated in paragraph 3 of Government Resolution No. 4326, dated the 15th July 1907, is adhered to.

" 3. The examination of the financial details of these projects, coupled with inquiries into the financial position of existing installations, has received a great deal of attention at the hands of the Board, with the result that they have arrived at conclusions which, in their respectful opinion, are sufficiently important to be placed before Government for further action

" 4. These conclusions are shortly as follows.

" 5. In the first place as regards existing works. The Board observe that though these works have been almost entirely constructed by loans advanced by Government, supplemented in places by grants from Government, or the district local board. no connected record of the financial history of each work exists, and that, if information is required as to the method in which any particular installation has been financed in the past, it is almost impossible to obtain it except by a long and painful search into a series of municipal reports, supplemented possibly by enquiry into local records. In the opinion of the Board this is not as it should be. They consider that each municipality should be called on to prepare and maintain a connected account of the financial history of all water and drainage installations within their limits.

" 6. This account should in their opinion contain full details regarding the cost of the project, showing clearly the original expenditure as well as that on additions made on capital account from time to time. The amounts spent on up keep every year should also be given.

" 7. On the revenue side, an account of the taxes imposed, or charges made since the opening of the works should be given, and the proceeds. Of these the most important is or should be the direct revenue from the sale of water. For convenience sake this may be divided into two parts :—

(i) revenue from connections for—

(*a*) domestic use,

(*b*) trading purposes,

(*c*) gardens.

(ii) revenue from distribution by rates for the same three purposes.

" 8. Next to direct revenue in importance comes indirect revenue, which is usually levied in one of two ways: (1) in a tax at so much per cent. on rental value, (2) in an increase of octroi. Figures under these heads should be clearly given.

" 9. Finally there should be full details as to the way in which money for capital expenditure has been found, what loans have been taken, what have been

paid off, and what arrangements are in force to discharge existing liabilities. In cases where sinking funds exist, the sums at their credit should be stated, as well as the amount of the annual contribution.

"10 It is possible, in fact, as regards some places probable, that the municipality may be unable to furnish this information in a succinct and intelligible form. We would recommend that, when the Collector thinks it necessary, an accountant from the office of the Accountant General or Examiner be deputed to correct the figures. In Ahmedabad this appears to be highly necessary. The figures supplied in the statement on pages 164 to 167 of the annual report on the administration of municipalities for 1910 are quite unintelligible.

'11. These accounts, when ready, will of course have to be kept up to date from year to year and for this purpose, the Board recommend that, in the annual report of each municipality possessing a water installation, the results of the year's working of the water installation should be separately shown and discussed. The proportion of the revenue derived from (*i*) direct sale of water, (*ii*) indirect taxation should be clearly shown.

"12. The object, however, of this letter is not I am to explain, merely to ask for the support of Government in collecting statistical information, but the far more important one of soliciting Government approval to a definite line of policy A study of the various expedients, which have been resorted to to meet the cost of various water works, has shown great diversity in the methods of taxation adopted; in some cases the principal reliance has been on octroi, in some on taxation on rental, in one or two on direct revenue from connections and sale by meter. But in no case was any clear principle followed; as long as the money was forthcoming somehow, the scheme received official sanction. The Board feel that the time has come when the influence of Government may be exerted to place things on a sounder basis. They think it necessary to remind the educated public of the Presidency that the water is a commodity, the supply of which is managed in many parts of the world by private companies as a commercial undertaking and that justice and expediency demand that the largest part of the revenue should be raised by direct sale. Particularly is this the case as regards new installation. Here Government are now providing from one-third to one-half the capital, and lending the remainder at the low rate of 4 per cent. With the capital necessary to erect the water works found for them on these very easy terms, the local body should, the Board consider, have no difficulty whatever in providing at least 80 per cent of the annual instalment in repayment of capital and interest by direct charges for sale of water, without the necessity of recourse to indirect taxation.

"13. It may perhaps be objected that insistence on these principles will make water works unpopular; and that, as long as money is provided, it is hardly necessary to enforce observance of the principles dear to the strict political economist. In the opinion of the Board there are two answers to this objection. In the first place an indiscriminate resort to indirect taxation is almost certain to cause financial injustice by enabling tax-payers of the upper and middle classes to shift an undue part of the burden, which should fall on them, on to shoulders of the lower classes, or still more through the agency of octroi on to the residents of villages which buy their supplies in the town. In this connection the Board instruct me to lay emphasis on a fact, not generally realized, that the provision of a piped supply of water is to a member of the upper or middle classes the means of considerable personal saving It has been proved by enquiries in many places that a household of this class ordinarily spends from Rs. 30 to Rs. 40 a year on the carting and conveying of water; while pots and ropes alone are said on good authority to cost Rs. 3. It is obvious, therefore, that even if, which is rarely the case, a household is called on to pay Rs. 15 for a half-inch pipe connection, its expenditure on water is reduced by 100 per cent. and that, if the charge for the pipe connection is lowered to Rs. 9, as in Jalgaon, or to Rs. 3 as is common in Ahmedabad, the household is not paying enough and that some part of the revenue necessary to defray water charges is being shifted on to shoulders less able to bear it or is being recovered by raising the scale of octroi duties to the prejudice of the trade of the town.

"14. A second answer to the objection lies in the fact, of which the Board have had ample proof, that due attention to the importance of direct taxation renders it much easier to arrange the financial details of schemes; in fact that it makes many practicable which it would be impossible to carry out without it.

Even therefore should the adoption of the policy now recommended arouse resentment at the outset, there will be ample compensation in the increase in the number of schemes, which this step will render possible hereafter.

"15. For these reasons I am instructed by the Board to suggest that Government will be pleased to lay down that the attention of municipalities should be directed to the desirability of defraying charges incurred for the supply of water including interest on, and repayment of, capital from revenue derived from the direct sale of water; and that they should prescribe as a condition on which Government grants will be given in aid of a water scheme that the minimum charge for a half-inch and three-quarter-inch pipe connections shall be Rs. 12 and Rs. 24, respectively; and that supply by pipes of large dimensions shall only be given by meter at a minimum rate of 6 annas per 1,000 gallons.

"16 I am further directed to observe that the rules for the recovery of water tax in force in some places leave a good deal to be desired in the way of completeness and intelligibility. I am to state that the Board propose on receipt of Government orders on this letter to draw up a simple set of rules as a model for general adoption, departure from which on material points should not, it is suggested, be permitted without reference to them."

Government memorandum to the Secretary, Sanitary Board, Bombay Presidency, No. 1897, dated the 20th March 1912:—

"The undersigned presents compliments to the Secretary, Sanitary Board, Bombay Presidency, and with reference to his letter No. 2856, dated the 4th October 1911, is directed to request that Government may be furnished with a list of the municipalities whose accounts the Board wish to be examined and with information as to the nature of installations in each."

Letter from the Secretary, Sanitary Board, Bombay Presidency, No. D.-129, dated the 25th April 1912:—

"With reference to your memorandum No. 1897, dated the 20th March 1912, I have the honour to inform you that the Sanitary Board wish that all municipalities in this Presidency which have water and drainage installations within their limits should be called on to prepare and maintain a connected account of the financial history of these installations.

"2. I attach a statement* giving information as to the nature of installations in each municipality at present. A list† of the municipalities which will soon be provided with either a water or drainage installation is also attached."

RESOLUTION.—Copies of the Sanitary Board's letter should be forwarded to all Commissioners, the Accountant General, and the Financial and Public Works Departments for information. Copies should also be forwarded to all Collectors for information and for communication to the municipalities in their respective districts.

2. Government concur generally in the veiws expressed by the Sanitary Board.

3. In accordance with the recommendation contained in paragraph 5 of the Board's letter, all municipalities which maintain water and drainage installations should now be called upon to prepare and maintain a clear and connected account of the financial arrangements in connection with such installations. A list of the municipalities to which these orders apply is appended. In order that each municipality may present the information required in a uniform manner, Government propose to prescribe standard forms of accounts and statements; but it is desirable to acquire further experience in the light of actual facts before the details of such forms are finally settled. The provisional forms appended to this Resolution have accordingly been drawn up, and the municipalities concerned should now without delay proceed to prepare their accounts up to date in these forms so as to have them ready by the 31st October 1912. Their examination will then be taken up by a special staff of auditors, who will commence their work from the 1st November 1912.

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* Appended to this Resolution.

† Not printed.

4. The Governor in Council is pleased to sanction for the purposes of this special audit the following temporary establishment for a period not exceeding six months :—

		Rs.
2 senior auditors on	... ...	150 each.
2 junior auditors	... ...	90 each.
2 peons	... ...	9 each.

The aggregate cost of the establishment including travelling allowances for the period specified is estimated at Rs. 4,500, and the amount has accordingly been provided in the current year's budget. As, however, this special audit staff is to be entertained in the interests of the municipalities concerned, His Excellency in Council considers it equitable that these bodies should be jointly liable for the expenditure incurred, each one contributing in proportion to its gross income. The Accountant General should accordingly recover the charges on this basis. He should also be requested to report on the results of this special audit and to submit for final adoption standard forms of accounts and statements based on the experience so acquired.

5. In future the municipal administration reports should separately show and discuss the financial working of water installations as suggested in paragraph 11 of the Sanitary Board's letter.

6. As regards the general question raised in paragraph 12 of the Board's letter, the Governor in Council is pleased to direct that the following should in future be the conditions precedent to the sanction by Government of any grant or loan to a municipality for the construction or extension of water or drainage works :—

(*i*) that the municipality has presented to the satisfaction of the Sanitary Board the financial account prescribed above in respect of each of its existing water and drainage installations;

(*ii*) that in the case of the construction of new water works the municipal proposals for financing the project shall provide for the recovery by means of direct charges for the supply of water of at least 80 per cent. of the annual instalment due in repayment of capital and interest;

(*iii*) that, except in cases where Government may for special reasons consent to a reduced standard of charges, the municipality shall undertake to levy minimum rates of Rs. 12 and Rs. 24 for a half-inch and a three-quarter-inch pipe, respectively, while in the case of supply by pipes of large dimensions the charge shall be by the meter and at a minimum rate of 6 annas per 1,000 gallons; and

(*iv*) that the municipality shall bind itself to adopt and enforce such rules for the recovery of its water tax as may be approved in each case by the Sanitary Board.

J. L. RIEU,
Secretary to Government.

To

The Commissioner in Sind,
The Commissioner, N. D.,
The Commissioner, C. D.,
The Commissioner, S. D.,
All Collectors, including the Collectors and Deputy Commissioners in Sind,
The Sanitary Board,
The Surgeon General with the Government of Bombay,
The Sanitary Commissioner for the Government of Bombay,
The Sanitary Engineer to Government,
The Accountant General,
The Financial Department,
The Public Works Department.

No. of 1912.

Copy forwarded for information and guidance to

Wholly or partially completed works.

Statement giving information as to the nature of installation in each municipality in the Bombay Presidency at present.

Serial No.	Division.	Name of municipality.	Nature of installation.	Remarks.
1	Northern ...	Ahmedabad ...	Water-supply ...	Completed.
2	,, ...	,, ...	Drainage ...	Partially completed.
3	,, ...	Surat ...	Water-supply ...	Completed.
4	,, ...	Rander ...	,, ...	,,
5	,, ...	Thana ...	,, ...	Completed. Further improvements are under consideration.
6	,, ...	Bhiwndi ...	,, ...	Completed.
7	Central ...	Ahmednagar	,, ...	Completed. Futther improvements are under consideration.
8	,, ...	Bhingar ...	,, ...	Completed.
9	,, ...	Jalgaon ...	,, ...	Partially completed. Further improvements are under consideration.
10	,, ...	Dhulia ...	,, ...	Completed. Improvements in progress.
11	,, ...	Nasik ...	,, ...	Partially completed.
12	,, ...	Poona City ...	,, ...	Completed. Improvements in hand.
13	,, ...	,, ...	Drainage ...	Partially completed. Construction work in progress.
14	,, ...	Jejuri ...	Water-supply...	Partially completed.
15	,, ...	Poona Suburbs...	,, ...	Completed.
16	,, ...	Sholapur ...	,, ...	Completed. Improvements to water-supply sanctioned.
17	,, ...	Pandharpur ...	,, ...	Partially completed. Work in progress.
18	,, ...	,, ...	Drainage ...	Partially completed.
19	,, ...	Satara ...	Water-supply ...	Completed.
20	,, ...	,, Suburbs	,, ...	,,
21	Southern ...	Bijapur ...	,, ...	Partially completed. Work in progress.
22	,, ...	Dharwar ...	,, ...	,, ,,
23	,, ...	Hubli ...	,, ...	Completed.
24	,, ...	Alibagh ...	,, ...	,,
25	,, ...	Roha-Ashtami	,, ...	Partially completed.
26	,, ...	Ratnagiri ...	,, ...	Completed.
27	Sind ...	Hyderabad ...	,, ...	Completed. Further improvements are under consideration.
28	,, ...	Sukkur ...	,, ...	Completed. Further improvements are under consideration.

Form I.

Administrative accounts for ____________

General abstract of financial results showing the estimated cost of construction, the capital outlay thereon, the revenue derived therefrom and the expenses, etc.

Locality.	Serial No.	Particulars of works.	Estimated cost of construction.	Capital outlay.			Revenue account.				Net for the year. Difference between columns 10 and 11.		Average of 3 years.		Percentage on loan of		Remarks, Explanation of short realization, etc.
				To end of previous year.	During year.	To end of year.	Income.			Expenditure.	Profit.	Loss.	Profit.	Loss.	Profit.	Loss.	
							Direct.	Indirect.	Total.								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

Form II.

Administrative accounts for________________

Name of project______________________

Revenue account for and to end of______________________

Income on	Amount.	Expenditure on		Remarks.
I.—Direct Receipts.				
i (1) Revenue from connection for domestic use ...		Working expenses on the scheme—		
(2) Do. trading purposes...		Charges for loan— (1) Interest ...		
(3) Do. gardens ...				
(4) Miscellaneous ...		(2) Sinking Fund instalments...		
ii (1) Revenue from distribution by meter for domestic use ...		Depreciation ...		
(2) Do. trading purposes		General supervision (proportionate share), etc., etc....		
(3) Do. gardens ...				
(4) Miscellaneous ...				
Total ...				
II.—Indirect Receipts.				
(1) Tax at——on rental values				
(2) Increase of octroi ...				
(3) Miscellaneous ...				
Total ...				
Grand total ...				

FORM III.

Statement showing the details as to the way in which money for capital expenditure has been found.

Name of municipality.	Serial No.	Purpose of loan.	Authority for loan.		Amount of loan sanctioned.	Date and amount of loan taken up.		Source from which taken.	Period for which required.	Security.	Rate of interest.	Amount of loan including interest.	Loans paid off.		Balance of loan.	In cases in which sinking funds have been formed.			Remarks as to arrangements in force to discharge existing liability.
			Government Resolution No.	Date.		Date.	Amount.						Reference to payment.	Amount.		Sum at credit.	Amount contributed.	Total.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

PART IV.

WATER ANALYSIS.

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

RECENT RESEARCHES IN THE METHOD OF WATER ANALYSIS.

BY

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At the last meeting of this Conference a short paper was read by myself on the subject of the necessity for an uniform method of examining water in India, and my ideas on what appeared to me to be the best method was also discussed. Unfortunately at that sitting the opinion of members was not sufficiently unanimous on this important subject to come to any conclusion; indeed some doubt was expressed as to the advisability of continuing the method started at the King Institute in 1907. I shall just like to point out that within the year very interesting work confirming our original conclusions has been done by Major Flemming in Connor. The Wellcome Research Laboratory in Khartoum also are working on the same lines and have published some interesting and important results; a certain amount of work has also been carried out in Allahabad.

I therefore again wish to impress on the members of this Conference the two facts—(1) the ideas published in the Madras report of 1909 have been favourably reported on in other parts of the world, and the work has received a certain amount of confirmation, and (2) that, while admitting that improvements in method will probably be evolved, it is necessary to go into considerable detail if the results obtained in the ordinary routine work are to be of use in explaining the phenomena observed in nature.

During the last 3 or 4 years some of the ideas, which were published in the King Institute report of 1909, have required slight modification, but speaking generally the main facts appear to have stood the test of further investigation very well. Of course a good deal of progress has been made, and new problems have been investigated, it is one of these that I propose to discuss with you now, but the method in use is a sound one and its general adoption is therefore the more urgent.

It has long been a debatable point amongst water analysts as to whether the first stage in an analysis should be made with glucose or a lactose broth. MacConkey and Hill first started with a glucose broth in order to include Gaertner and enteric organisms. Latterly MacConkey decided that a lactose broth was better, Houston has always begun with a glucose broth. In the King Institute in 1909 an investigation was made putting every sample through both. The results obtained are given in table No. 1; the important conclusion which this table shows may be given as follows:—

(1) That in practically every case a very much smaller quantity of the sample of water gives acid and gas in glucose than in lactose. If it were possible to make a sort of rough average out of these 77 samples, it would appear that in the lactose broth all dilutions up to 5 c. c. gave acid and gas whereas in the glucose broth dilutions up to ·1 of a c. c. gave the reaction. If each sample is examined in turn, it will be found that out of these 77 only about 6 show that the number of organisms is approximately the same in both broths. It may also be noted that all, except one, of these samples are taken from rivers, or irrigation canals.

It has been well known to water analysts for a very long time that what we may call " the acid and gas line " in lactose broth series is nearly always lower than in glucose broth.

(2) A careful scrutiny of the results obtained from the separate colonies is also necessary. In the first place, out of 770 colonies obtained from a lactose broth not a single one was glucose minus, that is to say, in this investigation all fæcal lactose fermenters ferment glucose. On the other hand, the organisms grown in a glucose broth and plated on a lactose medium show very different results. The figures are found at the bottom of the Table I, *viz.*, about half of these organisms are glucose+lactose. A very small percentage ferment neither glucose nor lactose ; no systematic study has been made of this small group up to the present. They are organisms which are obviously able to grow in a glucose broth without fermenting that sugar.

It should be observed that these samples were taken during July, August and September 1909. It is not maintained that the relative percentage of the three classes of organisms is constant at all times of the year. In fact, we shall show later on that this is not the case.

(3) Another point which should be noticed in connection with this table is that if the figures obtained from lake waters are compared with those of river waters, the relation between the two groups of bacilli is different in the two sources; thus glucose+lactose+form 42 per cent of the organisms obtained from lakes, whereas in rivers and ground waters this class forms 76 per cent. Therefore, it would appear that waters that have had considerable exposure to the sun contain more glucose+ lactose-variety than do the others.

These results were subsequently confirmed by a year's work on the Calcutta water and the Hughli, the conclusions being practically identical with those arrived at from the Madras work. Again a careful scrutiny of Houston's results shows that the same thing applies in England, particularly is it noticeable that the class of bacteria which are glucose+lactose are much more prevalent in summer than in winter.

Considering this mass of evidence we may consider that the following points are fairly certain :—

(1) that the acid and gas line in glucose medium is higher than in lactose in ordinary natural water;

(2) that the relation between the two classes of organisms varies at different times of the year ;

(3) that the relation between the two classes of organisms seems to be in some way connected with the amount of storage, or exposure to the sun.

We have always laid down that if a proper understanding of fæcal pollution in water is to be arrived at, a thorough knowledge of bacteriology of fæces is necessary. Consequently a careful investigation was started to ascertain what was the relation between the two classes of organisms, *viz.*, glucose—lactose— and glucose + lactose + in fæces. As a result of a very long series of work the details of which are given in Chapter III of "Bacteriology of Surface Waters in the Tropics" the following conclusions were arrived at :—

(1) That, from investigations carried out at different times during four years, we find that the particular group of organism whose fermentative reactions are glucose + lactose, are rare in the fæces of human beings and animals as a whole, 5 per cent or under representing their numerical value in a mixture. The common fæcal organism ferments both lactose and glucose.

(2) As far as can be ascertained at present "epidemics" of these organisms have not been met with, during the three or four years that the study of fæces has been going on.

(3) Separating the organisms out with sugar reactions does not show that any member of the group is particularly common; it is to be observed that organism P. is rare rather than otherwise.

Hence we are faced with the problem that in fresh fæces the class of bacteria glucose + lactose—are very rare, in water that has been stored for a long length of time, they represent about 90 per cent of all organisms present. This is a very violent change and requires explanation. Within the compass of this short paper the history of this investigation cannot be given, but it may be stated as a result of a great deal of experimental work, it has been discovered that when fæces is passed into water practically all organisms of both classes commence to die, but one particular member of the group glucose + lactose—is extremely comfortable in water and in a few days commences to multiply with great rapidity. This organism, which we call Bacillus P., overgrows all others and in 5 or 6 weeks may often be found as plentiful as 100 per the c. c. whereas the lactose fermenters have usually decreased to about 1 in 10 or 20 c. c. and only the more resistant varieties of these surviving. It is pretty obvious that in between these two extremes there are certain intermediary stages, hence the increasing prevalence of Baccillus P. accompanied a simultaneous falling off in the number of the lactose fermenters is indicative of departure from the original fæcal arrangement, and the increasing age of the pollution. In the laboratory this is demonstrated by the widening of what we know as the "acid and gas line" in the two media; thus, in recently polluted water the acid and gas line in glucose and lactose broth is identical, but as time goes on there is a gradual widening between the two. If fresh fæces and water are mixed together experimentally, the acid and gas line would occur in both glucose and lactose broth in let us say, ·01 c. c. After a week, if the water is exposed to the bright sunlight in a lake or river, glucose fermenting organisms will be present in say ·1 c. c. and lactose only in 5 c. c. In about a month glucose fermenting organisms would probably be present in ·05 or ·03 of a c. c. and lactose fermenters in 20 c. c. *Within certain limits the greater the difference between the two broths the older the pollution.* Those who want evidence on which this statement is based should refer to Chapter VI of the "Bacteriology of Surface Waters in the Tropics" where every step has been carefully investigated and all the evidence is given.

Assuming the truth of these statements, it is obvious that by the use of two broths reasonably accurate information can be obtained as to whether the pollution is very recent, is very old, or has departed considerably from the original fæcal arrangement. This in itself is an extremely important fact, and combined with other evidence may be of extreme value in dating the time of pollution of any known water. One example of this may be quoted. At the Murshidabad water works, at the height of the dry weather, when the water in the river had had a great deal of exposure to the sun, a sample taken at the intake gave the acid and gas line at ·1 c. c. in both broths. In addition to this the mixture of bacteria shows the presence of susceptible organisms. Considering the season of the year this was a very unusual result, and the conclusions drawn from this was that pollution of a dangerous and recent nature was being added in the immediate neighbourhood of the intake; on inspection it was found that a brick field has been started in close proximity to the water works, and that the labour employed were in the habit of using the river as a latrine immediately above the intake.

Of course it is not maintained that a study of the acid and gas line in any sample of water will tell an analyst everything he wants to know, but at the same time in many samples of raw water (the same does not apply absolutely to waters that have been in pipes) to ascertain the time when pollution was added is a very important point, and the use of the two broths will give very valuable evidences on this point. It may be argued that here again we have added another additional complication to the already cumbersome routine of water analysis. In answer to this one has to say that for ordinary routine work a study of the lactose fermenters present is sufficient, but there are instances when every particle of evidence is required to confirm an important opinion, and there can be no doubt whatever that a study of the relative number of the two classes of bacteria will give much valuable and accurate information.

Several examples of recently polluted and dry weather samples are appended.

TABLE I.

Comparative results of Glucose and Lactose Broth on Madras Water Samples.

—	Lactose Broth.								Glucose Broth.								Remarks.
	20 c.c.	10 c.c.	5 c.c.	1 c.c.	·1 c.c.	·01 c.c.	Lactose +	Glucose +	20 c.c.	10 c.c.	5 c.c.	1 c.c.	·1 c.c.	·01 c.c.	Lactose +	Glucose +	
1 Dodabetta Upper ...	+	+.	—.	—	—	—	10	10	+	+	+	+	+	—	10	12	
2 ,, Lower ...	+	+.	—.	—	—	—	10	10	+	+	+	+	—	—	9	12	
3 Tiger Hill Pipe ...	+	+	—.	—.	—	—	10	10	+	+	+	+	+	+.	0	12	
4 ,, ,, ...		nil.	nil.									nil.					
5 Dodabetta Pipe Line ...	+	—	—.	—.	—	—	10	10	+	+	+	—	—	—	0	12	
6 Marlimund ...	+	+	+.	+	+	—.	10	10	+	+	+	+	+	+	0	12	
7 ,, Pipe Line ...	+	+	.	—	—	—	10	10	+	+	+	+	+	—	...	...	
8 Kodapamund ...	+	+	—	+	—	—	10	10	+	+	+	+	—.	—	9	12	
9 Old Ootii ...	+	+	+.	—.	—	—	10	10	+	+	+	+	+	+	9	12	
10 Guntur Spring ...	+	+	+	—.	—	—	10	10	+	+	+	+	+	+	2	12	
11 ,, Filtered ...	+	+	+	+	—	—	10	10	+	+	+	+	+.	—	0	12	
12 ,, Tap ...	+	+	+	+	+	—	10	10	+	+	+	+	—.	—	10	12	
13 ,, Tap ...	+	+	+	+	—	—	10	10	+	+	+	+	+	—	10	12	
14 ,, Tap ...	+	+	+	+	+.	—	10	10	+	+	+	+	+	+	9	12	
Madras.																	
15 Sholavaram Tank ...	+	+	+	+	+.	+.	10	10	+	+	+	+	+	+	10	12	
16 ,, Channel ...	+	+	+	+	—.	—	10	10	+	+	+	+	+	+	6	12	
17 Red Hills ...	+	+	+	+	—.	—	10	10	+	+	+	+	+	+.	5	12	
18 ,, Tap ...	+	+	+.	—.	—	—	10	10	+	+	+	+	+	+	6	12	
19 ,, Tap ...	+	+	+	—.	—	—	10	10	+	+	+	+	+	+.	2	12	
20 Kurnool ...	+	+	+	+	+	+	10	10	+	+	+	+	+.	+.	9	12	
21 ,, Settling Tank ...	+	+	+	+	—.	—	10	10	+	+	+	+	+	+.	5	12	
22 ,, 2nd ,, ...	+	+	+	+	+.	—	10	10	+	+	+.	+	+	+.	8	12	
23 ,, Filtered ...	+	+	+	+	—	—	10	10	+	+	+	+	+.	—.	8	12	
24 ,, Tap ...	+	+	+	—	—	—	10	10	+	+	+	+	+	+	1	12	
25 ,, Tap ...	+	+	+	—	—	—	40	10	+	+	+.	+	—	—	7	12	
26 ,, Tap ...	+	+	+	—	—	—	10	10	+	+	+	+.	—	—	10	12	
27 Coonoor ...	+	+	—.	—	—	—	10	10	+	+	+	+	+	—	4	10	2 Lactose—Glucose—
28 ,, Reservoir ...	+	+	+.	+	—	—	10	10	+	+	+	+	+	—.	1	12	
29 ,, Tap ...	+	+	+.	+	—	—	10	10	+	+	+	+	—	—	12	12	
30 ,, Tap ...	+	+	—.	—.	—	—	10	10	+	+	+	+	+	—	12	12	
31 Adoni Spring ...	+	+	+.	+	+.	—.	10	10	+	+	+	...	...	...	9	12	
32 ,, Reservoir ...	+	+	+	+	—	—	10	10	+	+	...	+	+	—	5	12	
33 ,, Filtered ...	+	+	+	—	—	—	10	10	+	...	+	+	+	—.	8	12	
34 ,, Tap ...	+	+	+	—	—	—	10	10	+	+	+	+	+	—.	..	..	
35 ,, Tap ...	+	+	+.	+	—	—	10	10	+	+	+	+	+	+.	7	12	
36 Cocanada Canal ...	+	+	+	—	+	+	10	10	+	+	+	+	+	+.	11	12	
37 ,, Tank ...	+	+	+	+.	—	—	10	10	+	+	+	+	+.	—.	10	10	
38 ,, Filtered ...	+	+	+.	+	—	—	10	10	+	+	+	+	+	—	7	10	
39 ,, Tap ...	+	+	+	+	—	—	10	10	+	+	+	+	+	—.	0	12	
40 ,, Tap ...	+	+	+	+	—	—	10	10	+	+	+	+	+	+	2	12	
41 Conjeeveram ...	+	+	+	—.	—	—	10	10	+	+	+	+	+	—	0	12	
42 ,, Filtered ...	+	+	+	—	—	—	10	10	+	+	+	+	+	—.	0	12	
43 ,, Tap ...	+	+	+	—	—	—	10	10	+	+	+	+	+	—.	0	12	
44 ,, Tap ...	+	+	+	—	—	—	10	10	+	+	+	+.	—	—	2	10	2 Lactose—Glucose—
45 Madura River ...	+	+	+	—	—.	—	10	10	+	+	+	+	+	+	12	12	
46 ,, Filtered ...	+	+	+	—	—	—	10	10	+	+	+	+	+	—	7	7	5 ,, ,,
47 ,, Tap ...	+	+	+	—.	.	—	10	10	+	+	+	+	—	—	7	8	4 ,, ,,
48 ,, Tap ...	+	+	+	—	—	—	10	10	+	+	+	+	—.	—	6	6	6 ,, ,,
49 Nellore River ...	+	—	+	—	—	+	10	10	+	+	+	+	+	+	9	12	
50 ,, Filtered ...	+	—	—	—.	—	—	10	10	+	+	+	+	+	+	5	12	
51 ,, Tap ...	+	+	+	+	+	—	10	10	+	+	+	+.	—	—	12	12	
52 ,, Tap ...	+	+	—	+	—	—	10	10	+	+	+	+.	—	—	12	12	
53 ,, Tap ...	+	+	—	+	—.	—	10	10	+	+	+	+	+	—	0	12	
54 Tanjore ...	+	+	—	+	+	—	10	10	+	+	+	+	—.	+	7	8	4 ,, ,,
55 ,, Filtered ...	+	+	+	—	—	—	10	10	+	+	+	—	—.	—	10	11	1 ,, ,,
56 ,, Tap ...	+	+.	+	—	—	—	10	10	+	+	+	+	—.	—	12	12	
57 ,, Tap ...	+	+	+	—	—	—	10	10	+	+	+	+	+	+	5	12	
58 Trichinopoly ...	+	+	+	—	+	+.	10	10	+	+	+	+.	+	+	10	11	
59 ,, Filtered ...	+	+	+	+	—.	—	10	10	+	+	+	+	+.	—	3	5	7 ,, ,,
60 ,, Tap ...	+	+	+	+	—	—	10	10	+	+	+	+	+	—	4	11	1 ,, ,,
61 ,, Tap ...	+	+	+	+	—	—	10	10	+	+	+	+	+.	+.	9	11	1 ,, ,,
62 Tirupati ...	+	+	+	+	+	—	10	10	+	+	+	+	+	+	11	12	
63 ,, Well ...	+	+	+	+	—.	—	10	10	+	+	+	+	+	—	6	12	
64 ,, Filtered ...	+	+	+	—.	—	—	10	10	+	+	+	+	+	+	4	12	
65 ,, Tap ...	+	+	+	+	+	—	10	10	+	+	+	+	+	+	9	12	
66 ,, Tap ...	+	+	+	+	+.	—.	10	10	+	+	+	+	+	+	8	12	
67 Cuddapah ...	+	+	+	+	—.	—	10	10	+	+	+	+	+	+	4	12	
68 ,, Tap ...	+	+	+	+	—	—	10	10	+	+	+	+	—	—	4	12	
69 ,, Tap ...	+	+	+	+	—.	—	10	10	+	+	+	+	+	—	4	8	
70 Vizagapatam Lake ...	+	—	+	+	—.	—	10	10	+	+	+	+	+	—	1	10	
71 ,, Filtered ...	+	+	+	.	—	—	10	10	+	+	+	+.	—	—	2	10	
72 ,, Tap ...	+	+	+	—	—	—	10	10	+	+	+	+	—	—	0	10	
73 ,, Tap ...	+	+	+	—.	—	—	10	10	+	+	+	+	+	—	2	10	
74 ,, Tap ...	+	+	+	—.	—	—	10	10	+	+	+	+	+	—	0	10	
75 Dindigal Gallery ...	+	+	+	+	+	+	10	10	+	+	+	+	+	+	5	12	
76 ,, Well ...	+	+	+	+	+.	—	10	10	+	+	+	+	+	—	7	12	
77 ,, Tap ...	+	+	+	+	—.	—	10	10	+	+	+	+	+	+	7	11	1 ,, ,,
78 ,, Tap ...	+	+	+	—.	—	—	10	10	+	+	+	—	—	—	8	11	1 ,, ,,
Approximate Average ...	+	+	+	—.	—	—	770	770	+	+	+	+	+	—	447	842	35

Lactose + Glucose + 770	100 %	(in lactose broth.)
Do. + do. + 447	50·9 %	(in glucose broth.)
Do. — do. + 395	4·52 %	do.
Do. + do. — Nil	3·9 %	do.
Do. — do. — 35		

RECENTLY POLLUTED SAMPLES.

1
BERHAMPORE RIVER.—9·7-11.

			Glucose. +	Glucose. −	Lactose. +	Lactose. −
1	...	20	1	*Nil*	1	*Nil*
2	...	10	2	*Nil*	2	*Nil*
3	...	5	3	*Nil*	3	*Nil*
3	...	1	3	*Nil*	3	*Nil*
3	...	·1	3	*Nil*	3	*Nil*
3	...	·05	3	*Nil*	3	*Nil*
3	...	·03	3	*Nil*	3	*Nil*
3	...	·01	3	*Nil*	3	*Nil*
3	...	·005	2	1	1	2
3	...	·003	1	2	1	2
3	...	·001	*Nil*	3	*Nil*	3
			·005		·01	

	Sacchar.	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number.
1	+	+	—	—	+	—	—	75
2	—	—	—	—	—	+	—	Vesiculosus.
3	—	—	—	—	—	+	—	Do.
4	+	—	+	—	+	—	—	L. ærogenes.
5	+	+	—	—	—	—	—	?
6	—	+	—	—	—	+	—	Schafferi.
7	+	+	+	—	+	—	—	67
8	+	—	+	—	+	—	—	L. ærogenes,
9	—	—	—	—	—	+	—	Vesiculosus.
10	—	—	—	—	—	+	—	Do.

2
BERHAMPORE RIVER.—17-10-11.

			Glucose. +	Glucose. −	Lactose. +	Lactose. −
1	...	20	1	*Nil*	1	*Nil*
2	...	10	2	*Nil*	2	*Nil*
3	...	5	3	*Nil*	3	*Nil*
3	...	1	3	*Nil*	3	*Nil*
3	...	·1	3	*Nil*	3	*Nil*
3	...	·05	3	*Nil*	2	1
3	..	·03	3	*Nil*	1	2
3	...	·01	*Nil*	3	*Nil*	3
3	...	·005	*Nil*	3	*Nil*	3
3	...	·003	*Nil*	3	*Nil*	3
3	...	·001	*Nil*	3	*Nil*	3
			·03		·05	

	Sacchar.	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number.
1	—	—	—	—	—	+	—	Ves culosus.
2	—	—	—	—	—	+	—	Do.
3	+	—	—	—	—	+	—	Coscoroba
4	—	—	—	—	—	+	—	Vesiculosus.
5	—	—	—	—	—	+	—	Do.
6	—	—	—	—	—	+	—	Do.
7	+	—	+	—	+	—	—	L. ærogenes.
8	—	—	—	—	—	+	—	Vesiculosus.
9	—	+	—	—	—	+	—	Schafferi.
10	—	+	—	—	—	+	—	Neapolitanuu.

3
NAIHATI.—13-8-11.

			Glucose. +	Glucose. −	Lactose. +	Lactose. −
1	...	20	1	*Nil*	1	*Nil*
2	..	10	2	*Nil*	2	*Nil*
3	...	5	3	*Nil*	3	*Nil*
3	...	1	3	*Nil*	3	*Nil*
3	...	·1	3	*Nil*	3	*Nil*
3	..	·05	3	*Nil*	3	*Nil*
3	...	·03	3	*Nil*	3	*Nil*
3	...	·03	3	*Nil*	2	1
3	...	·005	3	*Nil*	2	1
3	...	·003	2	1	*Nil*	3
3	...	·001	2	1	*Nil*	3
			·001		·005	

	Sacchar.	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number.
1	+	+	—	—	—	+	—	Neapolitanus.
2	+	+	—	—	—	+	—	Do.
3	+	+	—	—	—	+	—	Do.
4	+	—	—	—	+	—	—	Cloacæ.
5	+	—	—	—	+	—	—	Do.
6	+	+	—	—	—	+	—	Neapolitanus.
7	—	—	—	—	—	+	—	Vesiculosus.
8	—	—	—	—	—	+	—	Do.
9	—	+	—	—	—	+	—	Schäfferi.
10	—	—	+	—	—	+	—	A. lactici.

4
NAIHATI.—13-10-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —		Sacchar.	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number.
1	...	20	1	Nil	1	Nil									
2	...	10	2	Nil	2	Nil									
3	...	5	3	Nil	3	Nil	1	+	—	+	—	+	—	—	L. ærogenes.
3	...	1	3	Nil	3	Nil	2	+	—	—	—	—	+	—	Coscoroba.
3	...	·1	3	Nil	3	Nil	3	—	—	—	—	—	+	—	Vesiculosus.
3	...	·05	3	Nil	3	Nil	4	+	—	—	—	—	+	—	Coscoroba.
3	...	·03	3	Nil	3	Nil	5	+	+	+	—	+	—	—	No. 67.
3	...	·01	3	Nil	3	Nil	6	+	—	+	—	+	—	—	L. ærogenes.
3	...	·005	3	Nil	3	Nil	7	—	—	+	—	—	+	—	Vesiculosus.
3	...	·003	3	Nil	1	2	8	+	—	+	—	—	+	—	Coscoroba.
3	...	·001	1	2	1	2	9	+	—	+	—	—	+	—	Do.
			·003		·005		10	+	+	+	—	—	+	—	Neapolitanus.

5
BUXAR RIVER—29-6-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —		Sacchar.	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number.
1	...	20	1	Nil	1	Nil									
2	...	10	2	Nil	2	Nil									
3	...	5	3	Nil	3	Nil	1	+	—	+	—	—	—	—	Gasiformans
3	...	1	3	Nil	3	Nil	2	—	+	—	—	—	+	—	Schafferi.
3	...	·1	3	Nil	3	Nil	3	+	—	+	—	—	+	—	Gasiformans.
3	...	·05	3	Nil	3	Nil	4	—	+	—	—	—	+	—	Schafferi.
3	...	·03	3	Nil	3	Nil	5	—	+	—	—	—	+	—	Do.
3	...	·01	3	Nil	3	Nil	6	+	—	+	—	—	—	—	Gasiformans.
3	...	·005	3	Nil	2	1	7	+	—	—	—	—	+	—	Coscoroba.
3	...	·003	Nil	3	Nil	3	8	+	—	+	—	+	—	—	L. ærogenes.
3	...	·001	Nil	3	Nil	3	9	+	+	—	—	—	+	—	Neapolitanus.
			·005		·005		10	—	—	+	—	—	+	—	Acidi lactici.

6
BUXAR RIVER.—24-8-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —		Sacchar.	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number.
1	...	20	1	Nil	1	Nil									
2	...	10	2	Nil	2	Nil									
3	...	5	3	Nil	3	Nil	1	+	—	+	—	+	—	—	L. ærogenes.
3	...	1	3	Nil	3	Nil	2	+	—	+	—	+	—	—	Do.
3	...	·1	3	Nil	3	Nil	3	+	—	+	—	—	—	—	Gasiformans.
3	...	·05	3	Nil	3	Nil	4	+	—	+	—	—	—	—	Do.
3	..	·03	3	Nil	3	Nil	5	+	—	+	—	+	—	—	L. ærogenes.
3	...	·01	3	Nil	3	Nil	6	+	—	+	—	+	—	—	Do.
3	...	·005	3	Nil	3	Nil	7	+	—	+	—	+	—	—	Do.
3	...	·003	1	2	2	1	8	+	+	+	—	+	—	—	67
3	...	·001	Nil	3	Nil	3	9	—	+	—	—	—	+	+	Coli. Com.
			·005		·003		10	+	—	+	—	—	—	—	Gasiformans.

7
BUXAR SETTLED.—48 hrs. 24-8-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —
1	...	20	1	*Nil*	1	*Nil*
2	...	10	2	*Nil*	2	*Nil*
3	...	5	3	*Nil*	3	*Nil*
3	...	1	3	*Nil*	3	*Nil*
3	...	·1	3	*Nil*	3	*Nil*
3	...	·05	*Nil*	3	*Nil*	3
3	...	·03	*Nil*	3	*Nil*	3
3	...	·01	*Nil*	3	*Nil*	3
3	...	·005	*Nil*	3	*Nil*	3
3	...	·003	*Nil*	3	*Nil*	3
3	...	·001	*Nil*	3	*Nil*	3
			·1		·1	

	Sacchar.	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number.
1	—	—	—	—	—	+	—	Grunthal.
2	—	—	—	—	—	+	—	Vesiculosus.
3	+	+	+	—	—	+	—	Neapolitanus.
4	—	—	—	—	—	+	—	Grunthal.
5	—	—	—	—	—	+	—	Vesiculosus.
6	—	+	—	—	—	+	—	Schäfferi.
7	—	—	—	—	+	+	—	Vesiculosus.
8	—	—	—	+	—	+	—	Do.
9	+	—	+	—	—	—	—	L. ærogenes.
10	+	—	+	—	—	—	—	Do.

8
HUGHLY (Howrah Bridge).—16-12-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —
1	...	20	1	*Nil*	1	*Nil*
2	...	10	2	*Nil*	2	*Nil*
3	...	5	3	*Nil*	3	*Nil*
3	...	1	3	*Nil*	3	*Nil*
3	...	·1	3	*Nil*	3	*Nil*
3	...	·05	*Nil*	3	1	2
3	...	·03	*Nil*	3	1	2
3	...	·01	1	2	*Nil*	3
3	...	·005	*Nil*	3	*Nil*	3
3	...	·003	*Nil*	3	*Nil*	3
3	...	·001	*Nil*	3	*Nil*	3
			·1		·1	

	Sacchar.	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number.
1	—	+	—	—	—	+	—	Schäfferi.
2	+	—	+	—	+	—	—	L. ærogenes.
3	+	—	+	—	+	—	—	Do.
4	+	—	—	—	—	+	—	Coscoroba.
5	—	—	—	—	—	+	—	Vesiculosus.
6	+	—	—	—	—	+	—	Coscoroba
7	+	—	—	—	+	+	—	Do.
8	+	—	+	—	+	—	—	L. ærogenes.
9	+	—	—	—	—	—	—	No. 111.
10	—	—	—	—	—	+	—	Vesiculosus

Streptococci present in 1 c. c.

9
ARRAH RIVER —22-7-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —
1	...	20	1	*Nil*	1	*Nil*
2	...	10	2	*Nil*	2	*Nil*
3	...	5	3	*Nil*	3	*Nil*
3	...	1	3	*Nil*	3	*Nil*
3	...	·1	3	*Nil*	2	1
3	...	·05	3	*Nil*	3	*Nil*
3	...	·03	3	*Nil*	*Nil*	3
3	...	·01	1	2	*Nil*	3
3	...	·005	*Nil*	3	*Nil*	3
3	...	·003	*Nil*	3	*Nil*	3
3	...	·001	*Nil*	3	*Nil*	3
				·03		·05

	Sacchar.	Dulcite.	Adonite.	Inulin.	V. and P.	Indol.	Motility.	Name or Number.
1	+	—	+	—	—	—	—	Gasiformans.
2	+	—	+	—	+	—	—	L. ærogenes.
3	—	+	—	—	—	+	—	Schäfferi.
4	—	+	—	—	—	+	—	Do.
5	+	+	+	—	+	—	—	No. 67.
6	+	+	+	—	+	—	—	Do.
7	+	+	+	—	+	—	—	Do.
8	—	+	—	—	—	+	—	Schäfferi.
9	+	+	+	—	—	—	—	Pneumoniæ.
10	+	—	+	—	+	—	—	L. ærogenes.

BHAGHALPUR.—28-7-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —		Sacchar.	Dulcite.	Adonite.	Inulin.	V. and P.	Indol.	Motility.	Name or Number.
1	...	20	1	*Nil*	1	*Nil*									
2	...	10	2	*Nil*	2	*Nil*									
3	...	5	3	*Nil*	3	*Nil*	1	+	+	—	—	—	+	—	Neapolitanus.
3	...	1	3	*Nil*	3	*Nil*	2	+	+	—	—	—	+	—	Do.
3	...	·1	3	*Nil*	3	*Nil*	3	—	+	—	—	—	+	—	Schafferi.
3	...	·05	3	*Nil*	3	*Nil*	4	+	+	—	—	—	+	—	Neapolitanus.
3	...	·03	3	*Nil*	3	*Nil*	5	+	—	—	—	—	+	—	Coscoroba.
3	...	·01	*Nil*	3	1	2	6	—	+	—	—	—	+	—	Schafferi.
3	...	·005	*Nil*	3	*Nil*	3	7	—	+	—	—	—	+	—	Do.
3	...	·003	*Nil*	3	*Nil*	3	8	+	+	—	—	—	+	—	Neapolitanus
3	...	·001	*Nil*	3	*Nil*	3	9	+	+	—	—	—	+	—	Do.
				·03		·03	10	—	+	—	—	—	+	—	Schäfferi.

11
BHAGHALPUR RIVER—28-7-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —		Sacchar.	Dulcite.	Adonite.	Inulin.	V. and P.	Indol.	Motility.	Name or Number.
1	...	20	1	*Nil*	1	*Nil*									
2	...	10	2	*Nil*	2	*Nil*									
3	...	5	3	*Nil*	3	*Nil*	1	—	+	—	—	—	+	—	Schafferi.
3	...	1	3	*Nil*	3	*Nil*	2	+	+	—	—	—	+	—	Neapolitanus.
3	...	·1	3	*Nil*	3	*Nil*	3	+	+	—	—	—	+	—	Do.
3	...	·05	3	*Nil*	3	*Nil*	4	+	+	—	—	—	+	—	Do.
3	...	·03	3	*Nil*	1	2	5	—	+	—	—	—	+	—	Schafferi.
3	...	·01	*Nil*	3	*Nil*	3	6	—	+	—	—	—	+	—	Do.
3	...	·005	*Nil*	3	*Nil*	3	7	—	+	—	—	—	+	—	Do.
3	...	·003	*Nil*	3	*Nil*	3	8	—	+	—	—	—	+	—	Do.
3	...	001	*Nil*	3	*Nil*	3	9	+	+	—	—	—	+	—	Neapolitanus.
				·03		·05	10	—	+	—	—	—	+	—	Schäfferi.

12
BURDWAN RIVER—16-8-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —		Sacchar.	Dulcite.	Adonite.	Inulin.	V. and P.	Indol.	Motility.	Name or Number.
1	...	20	1	*Nil*	1	*Nil*									
2	...	10	2	*Nil*	2	*Nil*									
3	...	5	3	*Nil*	3	*Nil*	1	—	—	+	—	—	+	—	A. lacitici.
3	...	1	3	*Nil*	3	*Nil*	2	+	—	—	—	—	+	—	Coscoroba.
3	...	·1	3	*Nil*	3	*Nil*	3	—	+	—	—	—	+	+	Coli. Com.
3	...	·05	3	*Nil*	2	1	4	+	+	—	—	—	+	—	Neapolitanus.
3	...	·03	3	*Nil*	1	2	5	—	+	—	—	—	+	—	Schafferi.
3	...	·01	3	*Nil*	*Nil*	3	6	+	—	+	—	—	+	—	......
3	...	·005	1	2	*Nil*	3	7	+	—	—	—	—	+	—	Coscoroba.
3	...	·003	*Nil*	3	*Nil*	3	8	—	+	—	—	—	+	—	Schäfferi.
3	...	·001	*Nil*	3	*Nil*	3	9	+	—	+	—	—	+	—	Gasiformans.
				·01		·05	10	+	—	+	—	+	—	—	L. ærogenes.

Observe in all these samples the closeness of the acid and gas line in glucose and lactose—the number of varieties in 10 colonies—the presence of Coli Communis or Schäfferi— and the general appearance of the mixture of bacilli.

DRY WEATHER SAMPLES.

ALL THESE ARE DRY WEATHER SAMPLES. OBSERVE THE RELATIVE FEWNESS OF BACILLI—THE FEW VARIETIES IN 10 COLONIES—THE ENTIRE ABSENCE OF COLI COMMUNIS AND THE DIFFERENCE BETWEEN THE GLUCOSE AND LACTOSE RESULT.

NAIHATI—9-11-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —		Sacchar.	Dulcite.	Adonite.	Inulin.	V. and P.	Indol.	Motility.	Name or Number.
1	...	20	1	Nil	1	Nil									
2	..	10	2	Nil	2	Nil									
"	.	5	3	Nil	3	Nil	1	+	—	+	—	+	—	—	L. ærogenes.
3	...	1	3	Nil	3	Nil	2	+	—	+	—	+	—	—	Do.
3	...	·1	3	Nil	3	Nil	3	+	—	+	—	+	—	—	Do.
3	...	·05	3	Nil	1	2	4	+	—	+	—	+	—	—	Do.
3	..	·03	3	Nil	1	2	5	+	—	+	—	+	—	—	Do.
3	...	·01	3	Nil	Nil	3	6	+	—	+	—	+	—	—	Do.
3	..	·005	3	Nil	Nil	3	7	+	—	+	—	+	—	—	Do.
3	...	003	1	2	Nil	3	8	+	—	+	—	+	—	—	Do.
	...	·001	1	2	Nil	3	9	+	—	+	—	+	—	—	Do.
			·005		·1		10	+	—	+	—	+	—	—	Do.

14

ARRAH RIVER—13-4-11.

			Glucose. +	Glucose. —	Lactose +	Lactose —		Sacchar	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number.
1	...	20	1	Nil	1	Nil									
2	...	10	2	Nil	2	Nil									
3	...	5	3	Nil	2	1	1	—	—	—	—	—	+	—	Vesicoulosus.
3	...	1	3	Nil	Nil	3	2	—	—	—	—	—	+	—	Do.
3	...	·1	3	Nil	Nil	3	3	—	—	+	—	—	+	—	A. lactici.
3	...	·05	...	...	...	...	4	—	—	—	—	—	+	—	Vesiculosus.
3	...	·03	...	...	...	...	5	—	—	+	—	—	+	—	A. lactici.
3	...	·01	Nil	3	Nil	3	6	—	—	+	—	—	+	—	Do.
3	...	·005	...	...	...	...	7	—	—	—	—	—	+	—	Vesiculosus.
3	...	·003	...	...	...	...	8	—	—	—	—	—	+	—	Do.
3	...	·001	Nil	3	Nil	3	9	—	—	+	—	—	+	—	A. lactici.
			·1		5		10	—	—	—	—	—	+	—	Vesiculosus.

15

MONGHYR RIVER—26-5-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —		Sacchar.	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number.
1	...	20	1	Nil	1	Nil									
2	..	10	2	Nil	2	Nil									
3	...	5	3	Nil	Nil	3	1	+	—	—	—	—	+	—	Coscoroba.
3	...	1	3	Nil	Nil	3	2	+	—	+	—	+	—	—	L. ærogenes.
3	...	·1	Nil	3	Nil	3	3	+	—	—	—	—	—	—	Coscoroba.
3	..	·05	...	...	...	...	4	+	—	—	—	—	+	—	Do.
3	...	·03	...	...	...	...	5	+	—	—	—	—	+	—	Do.
3	...	·01	Nil	3	Nil	3	6	+	—	—	—	—	+	—	Do.
3	...	·005	...	...	...	...	7	+	—	—	—	—	+	—	Do.
3	...	·003	...	...	...	...	8	+	—	—	—	—	+	—	Do.
3	...	·001	...	...	...	...	9	+	—	—	—	—	+	—	Do.
			·1		10		10	+	—	—	—	—	+	—	Do

16

DALTANGUNJ RIVER—10-12-11

			Glucose. +	Glucose. —	Lactose. +	Lactose. —
1	...	20	1	*Nil*	1	*Nil*
2	.	10	2	*Nil*	2	*Nil*
3	...	5	3	*Nil*	3	*Nil*
3	...	1	3	*Nil*	3	*Nil*
3	...	·1	3	*Nil*	1	2
3	...	·05	3	*Nil*	1	2
3	...	·03	3	*Nil*	*Nil*	3
3	...	·01	*Nil*	3	*Nil*	3
3	...	·005	1	2	*Nil*	3
3	...	·003	*Nil*	3	*Nil*	3
3	...	·001	*Nil*	3	*Nil*	3
				·03		1

	Sacchar.	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number.
1	—	—	—	—	—	+	—	Vesiculosus.
2	—	—	—	—	—	+	—	Do.
3	—	—	—	—	—	+	—	Do.
4	—	—	—	—	—	+	—	Do.
5	+	+	—	—	—	+	—	Neapolitanus.
6	+	+	—	—	—	+	—	Do.
7	—	—	—	—	—	+	—	Vesiculosus.
8	—	—	—	—	—	+	—	Do.
9	—	—	—	—	—	+	—	Do.
10	—	—	—	—	—	+	—	Do.

17

BHAGHALPUR—25-11-11.

			Glucose. +	Glucose. —	Lactose. +	Lactose. —
1	...	20	1	*Nil*	1	*Nil*
2	...	10	2	*Nil*	2	*Nil*
3	...	5	3	*Nil*	3	*Nil*
3	...	1	3	*Nil*	2	1
3	...	·1	3	*Nil*	*Nil*	3
3	...	·05	1	2	*Nil*	3
3	...	·03	1	2	*Nil*	3
3	...	·01	1	2	*Nil*	3
3	...	·005	*Nil*	3	*Nil*	3
3	...	·003	*Nil*	3	*Nil*	3
3	...	·001	*Nil*	3	*Nil*	3
				·1		1

	Sacchar.	Dulcite.	Adonite.	Inulin.	V. & P.	Indol.	Motility.	Name or Number
1	—	—	—	—	—	+	—	Vesiculosus.
2	+	—	—	—	—	+	—	Coscoroba.
3	+	—	—	—	—	+	—	Do.
4	—	—	—	—	—	—	—	Mutabilis.
5	+	—	—	—	—	+	—	Coscoroba.
6	+	—	—	—	—	+	—	Do.
7	+	—	—	—	+	—	—	Cloacæ.
8	+	—	+	—	+	—	—	L. ærogenes.
9	+	—	+	—	+	—	—	Do.
10	+	—	—	—	—	+	—	Coscoroba.

WATER-SUPPLY OF CALCUTTA, ITS PRESENT SYSTEM OF ANALYSIS AND ITS DISADVANTAGES BY RAI KAILAS CHANDRA BOSE BAHADUR, C.I.E.

Despite the assertion of the Sanitary Commissioner to the Government of Bengal as to the absolute purity of the filtered water-supply of Calcutta, the profession and the public alike have been very much disappointed in realizing its effect upon the health of the people of the town. The Health Officer in his comprehensive administration report is silent upon the point which deals with the causative factors of the prevalence of typhoid and para typhoid fever in Calcutta. The curve of enteric fever is steadily rising and if at this stage we do nothing but implicitly stick to the statement of the Sanitary Commissioner or rely upon the analysis of water as is weekly given in symbolic notation by the Health Officer of Calcutta, the day is not far distant when we shall have to repent of our unpardonable indifference, and our overconfidence in the present system of analysis will, I fear, soon betray us.

On looking through the records of the hospitals of Calcutta we find that within the last five years the water-borne diseases of the city have fast multiplied themselves and have taken a firm hold on Calcutta. There is not a single street or lane in the city in which you will not find one or two cases of typhoid or para typhoid fever, not to speak of dysentery or diarrhœa which has become almost a permanent evil amongst people living in the northern section of the town. It also frequently attacks high-class Europeans living in the best portion of the English quarter, and in fact disorder of the stomach and intestines was a common complaint of Europeans during the year 1911. The Health Officer was pleased to say that the water of Calcutta was exceptionally good and as such could not be a factor of disease. His view was emphatically supported by the Sanitary Commissioner. As a humble member of the profession and as one who is responsible to the public for the health of the city, I wish to ask how Major Clemesha can claim the superiority of his method over the system of analyses hitherto used in the laboratory of Calcutta and followed by no less a sanitarian than Professor W. J. Simpson himself. I have on more than one occasion tried to enlighten myself on this point, but I have failed.

I would in this paper respectfully place before the Conference the points on which further light is required for the benefit of the members of the Corporation who have to deal with the purity of the water and of the public who pay their water rates. When the town water was considered free from contamination by the sanitary experts we did not know in what direction to seek the sources of water-borne diseases. The necessity of obtaining thorough information regarding the character of Calcutta water has been created by the fact of the increased rate of mortality from enteric fever, dysentery and diarrhœa as shown by the following figures taken from the annual reports of the health department :—

Deaths from enteric :—

1903	51	1908	142
1904	69	1909	240
1905	88	1910	330
1906	145	1911	343
1907	141		

The Health Officer in his concluding remarks says that it is probable that many of the deaths returned under other fevers are really due to enteric.

Deaths from dysentery and diarrhœa—

1909	1,780	1911	1,938
1910	1,807		

The register of the Medical College Hospital shows an increase in the number of dysentery and diarrhœa cases treated in that institution. (The number includes both in-door and out-door patients.)

1909	854	1911	1,146
1910	983		

In his interesting report the Health Officer further describes a somewhat unusual outbreak of diarrhœa which occurred from September up to December. No deaths were reported as due to this particular form of diarrhœa; but it was extensively prevalent and in some instances the disease lasted for several weeks. There was not the

slightest reason to suppose that the water-supply of the city was connected with it. The same form of complaint was reported in other places outside Calcutta. It is a matter of great regret that he does not lay much stress on the bacteriological report of water during these months. His statement regarding the outbreak of diarrhœa in the suburbs and villages is not, in my opinion, a sufficient reason for excluding water-supply from the causative factors of diarrhœa, which though readily amenable to treatment markedly lowers the resistance of its victim and often reduces the wage-earning capacity of the industrious classes. He regrets he cannot tell us why the disease should especially select the Northern quarter for its operation. The reason is very simple, and it is that the Indians drink more water than the Europeans. The figures establish that water-borne diseases are on the increase, and unless the sanitary authorities are prepared to trace these outbreaks to some other factors we shall hold that the water-supply of the city is responsible for them.

In August 1909 the Local Government at the solicitation of the Corporation was pleased to depute Major Clemesha to ascertain the bacteriological condition of the river water as well as the filtered water-supply of the city, with instructions to report on the result of his investigations after one year. The Health Officer Dr. Pearse was also asked to associate with him in conducting the experiment in the laboratory of the Corporation. They decided that the existing system of water analysis was not sufficient to meet the demands of the age and that it should be replaced by one absolutely reliable and quite up-to-date. Major Clemesha and Dr. Pearse, after a careful examination of the site, source, settling tanks and filter beds at Pulta, decided that the water after its transit to the Calcutta reservoirs becomes slightly deteriorated in quality, but it was only during the rains that this change was noticed. They also after careful consideration rightly decided to change and did change the old form of analysis of water and the method of testing its purity; but the new system introduced, instead of improving matters, appears to have made them more complicated. In this new method of testing purity of water and giving the results of analysis in symbolic notation, the authorities have ignored previous standards of purity and left the profession and the people to understand it by the remarks of the Health Officer given at the bottom of the analytical report. As I am no expert of water analysis it would be presumptuous on my part to discuss the technique of the process Major Clemesha says that the formula he has introduced is one which was originally brought into practice by McConkey. I do not dispute the value of Dr. McConkey's process, but I do not understand why it should replace the one which appeared equally correct and certainly more easily understood by the members of the Corporation, most of whom do not understand the technique of the process. Since the introduction of the new system Dr. Pearse has discontinued giving bacterial counts and absolutely relied upon symbolic notation of the presence or absence of fœcal germs which alone he considers sufficient to indicate the wholesomeness or otherwise of the water we supply to the people of the town and its suburbs. But, in the absence of any reliable standard to limit the quantity of these pathogenic organisms, the utility of the formula is altogether lost. To enable you to come to a definite decision it would be necessary to place before you, side by side, the two systems, the old and the new, and comment on their respective merits. I beg leave to submit that in the old method the Health Officer, besides showing the presence or absence of pathogenic organisms, gave the bacterial counts which could at once enable the members to judge about the purity of water we supply to the people. The presence or absence of lactofermenters was also noted in the report. Bac. Entritides sporogenes, whose presence was a positive evidence of contamination, had a separate place in the report. The old method was safe and indicated whether the water could be passed as wholesome for domestic purposes. The object of the weekly report on the purity of water is not only to ascertain the quality of water but also to know how far it is accountable for the production of water-borne diseases of Calcutta. I have already said that diarrhœa, dysentery and enteric fever have enormously increased, and the Government and the people have a right to know their causative factors. The symbolic notation of the present system may be sufficiently explicit to the Health Officer, but it is hieroglyphic to others who do not understand the process.

The time has come when strenuous efforts should be made to introduce a reliable system of analysis of water-supply of the town.

TESTING THE PURITY OF FILTERED WATER FOR THE WEEK ENDING THE 17TH SEPTEMBER 1910.

The results are expressed in parts per 100,000.

Date and place of collection of sample.	Total solids.	Chlorine.	Saline ammonia.	Albuminoid ammonia.	Total hardness.	Permanent hardness.	Nitrogen as nitrates and nitrites.	Oxygen absorbed.	Sulphates.	Nitrites.	Remarks.
BHOWANIPORE RESERVOIR.											
A—Dated 191 ..	12·0	0·5	*Nil*	·0048	7·0	5·25	·012	·014	Present	*Nil*	Clear and transparent.
B—Dated 191 ..	11·5	0·8	*Nil*	·0048	6·5	5·75	·018	·007	Do.	*Nil*	
C—Hoogli River water at Pulta intake dated 191	62·5	0·4	·0012	·016	6·25	4·5	·024	·041	Do.	*Nil*	

BACTERIOLOGICAL EXAMINATION.

	Remarks.
(*a*) Number of microbes per cc., as shown by agar-plates kept at 37° C. for 2 days..	A = 50; B = 40.
(*b*) Microbes which are evidence of pollution—	
(1) Comma bacillus	Not present.
(2) Bac. Typhi Abdominalis	Not present.
(3) Bac. of "Colon group"	Present.
(4) Bac. Enteritidis Sporogenes	Not present.

(3) Lactose fermenters in 0 5 cc. (4) In less than 5 cc.

Forwarded to Chairman for submission before the General Committee—

(1) The chemical analysis of a sample from the Bhowanipore Reservoir gave good results.

(2) The bacteriological examination was satisfactory.

(3) The filter-beds seem to be working well.

H. M. CRAKE, M.D., D.P.H.,
Ag. Health Officer.

TESTING THE PURITY OF FILTERED WATER FOR THE WEEK ENDING THE 8TH OCTOBER 1910.

The results are expressed in parts per 100,000.

Date and place of collection of sample.	Total solids.	Chlorine.	Saline Ammonia.	Albuminoid Ammonia.	Total hardness.	Permanent hardness.	Nitrogen as Nitrates and Nitrites.	Oxygen absorbed.	Sulphates.	Nitrites.	Remarks.
BHOWANIPORE RESERVOIR.											
A—Dated 191	12·0	0·5	*Nil.*	·0048	7·0	5·25	·012	·014	Present.	*Nil.*	Clear and transparent.
B—Dated 191 ..	11·5	0·3	*Nil.*	·0048	6·5	5·75	·018	·007	Do.	*Nil.*	
C—Hoogli River water at Pulta intake, dated 191	62·5	0·4	·0012	·016	6·25	4·5	·024	·041	Do.	*Nil.*	

BACTERIOLOGICAL EXAMINATION.

	Remarks.
(*a*) Number of Microbes per cc., as shown by agar-plates kept at 37° C. for 2 days	A = 50; B = 40.
(*b*) Microbes which are evidence of pollution—	
(1) Comma bacillus	Not present.
(2) Bac. Typhi Abdominalis..	Not present.
(3) Bac of "Colon group"	Present.
(4) Bac. Enteritidis Sporogenes	Not present.

(3) Lactose fermenters in 1·5 cc. (4) In less than 5 cc.

Forwarded to Chairman for submission before the General Committee—

(1) The chemical analysis of a sample from the Bhowanipore Reservoir gave good results.
(2) The bacteriological examination was satisfactory.
(3) The filter-beds seem to be working well.

H. M. CRAKE, M.D., D.P.H.,
Ag. Health Officer.

REPORT ON THE PURITY OF THE CALCUTTA WATER-SUPPLY FOR THE WEEK ENDING THE 16TH MARCH 1912.

(a) Chemical Examination.

The results are expressed in parts per 100,100.

Date and place of collection of sample	Total solids.	Chlorine.	Saline ammonia.	Albuminoid ammonia.	Total hardness	Permanent hardness.	Nitrogen as nitrates and nitrites.	Oxygen absorbed.	Nitrites.	Remarks.
Pulta Filtered Water.										
A—Dated 191	27	1·7	Trace.	·(04	10·0	5·25	·008	007	*Nil.*	Clear and transparent.
B—Dated 191	26·5	1·8	*Nil.*	·0082	12·5	4·25	·010	·004	*Nil*	

(b) Bacteriological Examination.

				Remarks.
1.—Pulta Filtered Water.				
(a) Comma bacillus	..	..	..	Not present.
(b) Bacilli of "Colon Group."	1 cc	5 cc	10 cc	
Lactose fermenters—Present in				
2.—Pulta Intake Water.	·001	0·01	1 cc	
Lactose fermenters—Present in	—	—	—	
3.—Settled Water before Filtration.	0·1	1 cc	5 cc	
Lactose fermenters—Present in	—	—	—	
4.—Tallah Reservoir Water.	1 cc	5 cc	10 cc	
Lactose fermenters—Present in	—	+	+	
5.—Town Supply.	1 cc	5 cc	10 cc	
Standpost near 156, Dharrumtola Street ..	+	+	+	

\+ Indicates positive reaction, *i.e.*, production of both acid and gas.

— Indicates negative reaction, *i.e.*, neither acid nor gas produced.

$\frac{+}{-}$ Indicates production of acid but not of gas.

Forwarded to Chairman for submission before the General Committee—

(1) The chemical analysis shows the water to be of good quality.

(2) The bacteriological examination shows contamination of town supply.

(3) The filters for the most part seem to be working well.

T. F. Pearse, M.D., D.P.H.,
Health Officer.

REPORT ON THE PURITY OF THE CALCUTTA WATER-SUPPLY FOR THE WEEK ENDING THE 4TH MAY 1912.

(a) CHEMICAL EXAMINATION.

The results are expressed in parts per 100,100.

Date and place of collection of sample.	Total solids.	Chlorine.	Saline ammonia.	Albuminoid ammonia.	Total hardness.	Permanent hardness	Nitrogen as nitrates and Nitrites.	Oxygen absorbed.	Nitrites.	Remarks
PULTA FILTERED WATER.										
A—Dated 191	27	1·7	Trace.	·004	10·0	5·25	·008	·007	*Nil.*	Clear and transparent.
B—Dated 191	26·5	1·8	*Nil.*	0032	12·5	4·25	·010	·004	*Nil.*	

(b) BACTERIOLOGICAL EXAMINATION.

				Remarks.
1.—PULTA FILTERED WATER.				
(a) Comma bacillus	.. 1 cc	.. 5 cc	.. 10 cc	Not present.
(b) BACILLI OF "COLON GROUP."				
Lactose fermenters—Present in				
2.—PULTA INTAKE WATER.	·001	0·01	1 cc	
Lactose fermenters—Present in				
3.—SETTLED WATER BEFORE FILTRATION.	0·1	1 cc	5 cc	
Lactose fermenters—Present in	−	+	+	
4.—TALLAH RESERVOIR WATER.	1 cc	5 cc	10 cc	
Lactose fermenters—Present in . ..	−	+	+	
5.—TOWN SUPPLY.	1 cc	5 cc	10 cc	
Standpost near 156, Dharrumtola Street ..	±	+	+	

+ Indicates positive reaction, *i.e.*, production of both acid and gas.
− Indicates negative reaction, *i.e.*, neither acid nor gas produced.
± Indicates production of acid but not of gas.

Forwarded to Chairman for submission before the General Committee—

(1) The chemical analysis shows the water to be of good quality.
(2) The bacteriological examination gives satisfactory results.
(3) The filters for the most part seem to be working well.

T. F. PEARSE, M.D., D.P.H.,
Health Officer.

REPORT ON THE PURITY OF THE CALCUTTA WATER-SUPPLY FOR THE WEEK ENDING THE 28TH OCTOBER 1912.

(a) CHEMICAL EXAMINATION.

The results are expressed in parts per 100,100.

Date and place of collection of sample.	Total solids.	Chlorine.	Saline ammonia.	Albuminoid ammonia.	Total hardness.	Permanent hardness.	Nitrogen as nitrates and nitrites.	Oxygen absorbed.	Nitrites.	Remarks.
PULTA FILTERED WATER.										
A—Dated 191	27	1·7	Trace.	·004	10 0	5 25	·008	·007	*Nil.*	Clear and transparent.
B—Dated 191 .. .	26·5	1·8	*Nil.*	·0032	12·5	4·25	·010	·004	*Nil.*	

(b) BACTERIOLOGICAL EXAMINATION.

				Remarks.
1.—PULTA FILTERED WATER.				
(a) Comma bacillus	1 cc	5 cc	10 cc	Not present.
(b) BACILLI OF "COLON GROUP."				
Lactose fermenters—Present in .. .				
2.—PULTA INTAKE WATER.	·001	0·01	1 cc	
Lactose fermenters—Present in .. .				
3.—SETTLED WATER BEFORE FILTRATION	0·1	1 cc	5 cc	
Lactose fermenters—Present in . ..	+	+	+	
4.—TALLAH RESERVOIR WATER.	1 cc	5 cc	10 cc	
Lactose fermenters—Present in	−	+	+	
5.—TOWN SUPPLY.	1 cc	5 cc	10 cc	
Standpost near 156, Dharrumtola Street ..	−	±	±	

+ Indicates positive reaction, *i.e.*, production of both acid and gas.
− Indicates negative reaction, *i.e.*, neither acid nor gas produced.
± Indicates production of acid but not of gas.

Forwarded to Chairman for submission before the General Committee—

(1) The chemical analysis shows the water to be of good quality.
(2) The bacteriological examination gives satisfactory results.
(3) The filters for the most part seem to be working well.

T. F. PEARSE, M.D., D.P.H.,
Health Officer.

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

Water analysis in the Tropics with special reference to the adoption of Standard Methods in the collection and examination of Samples

BY

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Director, King's Institute of Preventive Medicine.

In Appendix 14 to the Proceedings of the First All-India Sanitary Conference, held at Bombay last year, Major Clemesha, I.M.S., re-urges his contention first put forward in 1909,[1] as to the desirability of uniformity in the methods employed in Water Analysis in India and elsewhere in the Tropics.

I do not think that the arguments put forward by Major Clemesha in support of his contention can be gainsaid, and personally only find fault with him for not having gone far enough. I would urge that in order to obtain comparable results it is necessary to collect, handle and examine the samples, both chemically and bacteriologically, in as nearly identical a manner as possible. Later on I propose to put forward for discussion, a scheme which I think would meet most of the points special to Tropical conditions.

In past discussions in India on this subject, a good deal of energy has been used up in championing the views of one bacteriologist against those of another, as to what is the best indication of excremental and dangerous pollution and as to what is the best means of detecting it. A very vital point, namely the climatic conditions under which the method would have to be worked has however been largely lost sight of. These conditions may affect our potentiality in opposite directions. In most parts of India, for instance, it is practically impossible to use gelatine media at all times of the year, unless under very exceptional circumstances. This is a very great handicap more especially in some of the more delicate confirmatory tests. On the other hand, Tropical climatic conditions induce a selective action in what may be called "natural purification processes" such as has not been noticed in temperate climates. This at once enables us to differentiate between pollution of recent date and that of old standing, and justifies us in carrying out routine work in greater detail than is usually the case in Europe.

On the whole I think a modified MacConkey's method will probably prove to be the best suited to Tropical conditions, but there are one or two important points in connection with this method which must be borne in mind. (1) Being an enrichment method, the results got from it can only be considered qualitatively as regards any particular germ and more stringent precautions should, I think, be taken to prevent the swamping out of delicate forms by more robust and quicker growers either in actual fact or as observed, than is usually done. (2) Its analytical value has perhaps been overestimated.

The more tests one applies in differentiating groups of organisms the greater will be the number of species or varieties which will be obtained, and it becomes a question at what stage of elaboration we should stop. For example in 1909 (*opus cit*) Clemesha considers that B. Coli Commune of Escherich is sufficiently defined by certain tests, but in an elaborate investigation on Coli like forms, Houston [2] by excluding from a very large number of colonies all those that did not produce gas in a glucose medium, separated out 80 different coli like forms which were subjected to further minute study. Six of these different varieties conformed to the tests prescribed by Clemesha. Houston further narrowed the area of investigation by excluding from the 80, all that did not ferment lactose and produce indol and found twenty-six varieties remaining. The same six mentioned above, or nearly 25 per cent of the total varieties, were found in the more strictly limited group. It cannot therefore be maintained that B. Coli Commune

has been strictly defined as yet. In Europe where water famines are rare and communities are wealthy and can afford to go in for effective precautions against great fluctuations in the quality of drinking water supplies, a less precise definition of what constitutes pollution may be all that is required, since it can be confidently stated that such pollution, even if present in the water from the source, will not be present in the water as distributed. In India where the conditions are quite the reverse, it becomes necessary to be more precise in the distinction between recent and therefore potentially dangerous pollution, and old standing pollution which cannot be got rid of, but which would condemn the water from the European point of view. Certain objections against the MacConkey method were raised at the Conference last year, [3] but there seems to have been some confusion of thought with regard to these. It was held that the method took too long and that by the time the results were reported, all the conditions might have altered and effective action could not be taken. From this point of view, it is necessary to define what a properly conducted analysis can show. It can only show and it ought to show the condition of the water at the time the sample was taken. No method therefore, however short, conveys any guarantee as to the state of affairs when the report is presented.

Further it was held that the greater elaborateness of MacConkey's method made greater demands on the efficiency of the filters and their management than would a shorter and less precise method. Surely it is obvious that the more we differentiate between one form of pollution and another, the more we will be able in the case of a given group of water supplies to limit the number containing specifically dangerous pollution, and the greater number we will be able to pass as fit for consumption. Specific instances were given where the filtered water was shown to be worse than the unfiltered water. Such a showing cannot be attributed to the method employed; it would be shown by any method. Another point raised was why go in for such elaborate analysis when you cannot distinguish pollution of human origin which alone is dangerous from that originating with other animals. However desirable it may be that we should have such a means of differentiation, much stress need not be laid on its absence under Indian conditions. The great mass of pollution originating with lower animals will in so far as it affects drinking water supplies, that is to say occurs in the neighbourhood of populous centres, be due to domestic animals. Now where domestic animals go, human beings will follow, and demean themselves as regards these natural functions with a like absence of restraint Even therefore if we could show that usually the pollution occurring in a water was derived from lower animals, we would not be able to exclude the chance of more serious pollution from time to time. In most cases the important point to determine will be, is recent pollution a thing of regular occurrence? If the answer is in the affirmative we need have little hesitation in assuming that it is also dangerous. By recent pollution I mean of course recently voided pollution, not merely recently introduced into the water. After discussing these more or less general questions we may now proceed to special ones and we should first ask ourselves—what are the objects at which we are aiming in carrying out water analyses at all, and how may these objects be most efficiently attained? Our objects are—

(1) To investigate new supplies.

(2) To control and ensure the proper management of existing supplies.

(3) To establish standards of bacterial and chemical purity which should be attained wherever possible.

(1) This is a most important branch of the work, as on the results of the analysis will depend the type of headworks put up so as to ensure the best results with the water. Preliminary rough analysis should be carried out to show whether the water is at all possible, but after these there should be sets of full analyses which can hardly be too elaborate. These should be conducted wherever possible during the dry season, during the rains, and a short time after the rains.

(2) It may, I think, be taken for granted that for some time to come these analyses will have to be conducted at some central station. Water analytical laboratories in every municipality would be rather ahead of the age. This has

an advantageous aspect and a disadvantageous one, but I hope to show that the latter can be overcome. It is, I think, a distinct advantage that the controlling analyses be carried out by an independent party who has no interest in making the results appear better or worse than they really are. It is recognised in all walks of life, human nature being what it is, that tests designed to prove the quality of any work should not be carried out by the person whose work is under test. The disadvantage is that most places will be at long distances from the central station, and if samples have to be brought to the central station, long intervals will have to elapse between the drawing and the examination of a sample. In a climate like that of India this is a question of very great importance. Up to date it has been met by arranging for all samples for bacteriological analysis to be brought by hand and packed with plenty of ice, the bearer being instructed to renew the ice as often as may be necessary *en route*. This is undoubtedly a weak point in our present procedure. Ice supplies may be underestimated or may be non-available at expected points, and a variety of other things may happen. Accidents are of course less likely to happen in the case of routine samples where a regular arrangement for supplies can be made than in the case of stray samples brought by persons who do not understand the reasons for the instructions given, but it must always be understood that the fact of a sample arriving in a well chilled condition is no guarantee that it has been so chilled ever since it was drawn. The best way out of the difficulty appears to me to have the initial steps of the analysis carried out on the spot by some qualified person, preferably the District Medical Officer. With this object in view I have designed a box containing all that is necessary for the first steps. After these steps have been carried out the box will be locked and brought back to the laboratory by the special messenger. The box will contain a capacious boiler with a powerful spirit lamp. This serves the double purpose of melting agars for the total count and for maintaining the temperature of the box somewhere near 40° C. There will be test-tube racks with 15 tubes containing bile salt neutral red lactose broth in varying concentration, 4 tubes containing 9 c.c. of distilled water and 2 tubes containing ordinary agar. Futher there will be five Petri dishes, 3 containing MacConkey lactose agar, and two empty; also two sterilised—1 c.c. pipettes, spreaders, etc., in a metal case. The sample will be drawn in an ordinary or special stoppered sterilised bottle. All the tubes that are to contain more than 1 c.c. of the water will be marked so that they have only got to be filled up to the mark with the sample water and the contents mixed. With one of the 1 c.c. pipettes the operator will now add 1 c.c. of the water to each of 3 bile salt broth tubes, and to one tube containing 9 c.c. of water. This must be very well mixed with the pipette and from it 1 c.c. is added to 3 bile salt broth tubes, to an agar previously melted and cooled to 45° C, and to another tube of 9 c.c. distilled water. I regard this way of using at least 1 c.c. for making cultures, plates and dilutions as important. Attempts to add 1/10 of a cubic centimetre are likely to lead to error, and loopfuls are anathema to the accurate mind. The operator now proceeds to thoroughly mix the second dilution and using the same pipette adds 1 c.c. to each of 3 bile salt broth tubes and to the second agar melted and cooled as above. The agar tubes are now shaken to mix their contents and these are then plated out. At this stage the box is to be closed with the boiler inside to maintain the temperature, and as originally designed would have been handed over to the messenger for transport to the central laboratory. I am however convinced that an examination of the contents of the 20 c.c. tube after two, three or four hours, according to circumstances, would lead to very useful information. With this end in view I propose that after a certain quite short interval, which will depend on an *à priori* estimate of the quality of the water under examination, that smear plates on MacConkey agar be made from the 20 c.c. tube and from 1/10 and 1/100 dilutions of the same. These tests should be carried out long before there is any indication of growth in the tube, either in the sense of turbidity or of acid reaction, and I would hope to obtain from them a certain approximation to a quantitative estimate of the various species of lactose fermenters present. As noted above, the various species of germs may have varying rates of multiplication; so only an approximation can be hoped for, but by eliminating all chance of inhibition we would get a more correct view and

might hope to find on one or other of the 3 plates made a specimen of each species of lactose fermenter present in the original water. The richer the water was supposed to be in these germs, the shorter would be the interval before putting out the plates, and if a liberal amount of well dried MacConkey medium were used for the plates, it would be possible to use as much as a half or perhaps a whole cubic centimetre from the 20 c. c. tube and its dilutions without danger of swamping.

To illustrate the value of preparing plates at as early a period as possible, let us take a somewhat extreme case. Suppose in 20 c.c. of the water there were one each of species A and B, and that A took 30 minutes to divide and B 20 minutes. At the end of two hours there would be 4 of B for every one of A, at the end of three hours there would be 10 of B for every one of A, and at the end of four hours there would be 20 of B for every one of A. At the end of the third hour there would be sixty-four A and by preparing a plate with 0·5 c.c. of the mixture amounting to 25 c. c. say we should on examining 10-15 colonies have a good chance of detecting both A and B. This chance would rapidly diminish and at the end of 18 hours (the usual period for plating out) so far from a quantitative relationship between A and B being obtained, we should in all probability miss A, that is the qualitative factor altogether. Such a difference in the time of multiplication might be a very rare one, but it is quite possible for B to have an initial start of four to one when the difference of the time interval for multiplication might be greatly reduced and yet the result be much the same. This is the state of affairs which I meant to describe above as crowded out *by observation*. When plating out, the operator would take the opportunity of heating up the boiler if necessary to maintain the temperature of the boxes at the correct point. These boxes could be arranged in sets of four inside a larger case. Such a case would be a convenient load for a cooly, and would in most instances be enough for one station. The cases would be locked and the keys sent by registered post to the central station. The responsibility of the laboratory messenger would then be limited to bringing the cases to the station where the examination was to be made, to taking them back to the laboratory and to seeing that they were not turned topsy-turvy or roughly handled *en route*. This last might be arranged with the Railway authorities and by marking the cases in a very distinctive manner. Probably it would prove expedient to cap or rubber stopper the tubes containing liquids, instead of plugging them. I do not think there would be any objection to this in the case tubes containing bile salt broth, and the tubes containing distilled water might be sealed up. Arrived at the laboratory where duplicate keys would be available, the contents of the boxes would be placed in the incubator, and in some cases it would be possible to proceed at once with the total count and placing the colonies in the differention tubes containing various sugars, etc. A considerable saving of time would result from the adoption of a scheme such as this.

The question arises how often should a water supply be visited and examined? Considering that the results can only refer to the moment when the sample was taken, the maximum effect in controlling the proper working of the filters, tanks, etc., would be attained by visits at irregular intervals, according to circumstances, and without previous warning. Further, if any permanent benefit is to be expected from these examinations, it would be necessary to take effective action should such be shown to be required.

(3) Regarding the establishment of standards of purity, little need be said here. It is far too early yet to attempt to do anything of the sort. I have indicated above the changes which might be expected to arise from comparatively slight modifications in our methods, and until we have some sort of guarantee that different workers are pulling together, and under similar circumstances would get similar results, it is idle to talk of fixing standards. It has even been suggested [4] that the conditions within the Tropics vary within such wide limits that no setting of standards will ever be possible. It would certainly seem difficult to imagine standards which would suit such divers conditions as are met with in Bikanir and Cherapoonjee. In cases such as the former, the function of the analysis would be to indicate the best means of minimising such bad qualities as a water might display, but not to reject or pass it according to fixed

standards As to the best method of treating a water, it will be generally conceded that the simplest method that will yield results approximating to the desired end, will be the best.

In most cases storage with a preliminary sunning process will probably prove the best, but filtration with or without coagulants will be necessary in others. In future years, and when it is solely bacteriological defects we wish to remove some of the physical methods, *e.g*, ozone or ultra violet rays may come into use. In those days when it is becoming possible to fuse increasingly large masses of transparent quartz, the construction of a battery of quartz prisms need not be such a formidable affair. Any method involving the use of sunlight must however always involve considerable storage, as no work is possible at night or during considerable spells in the rainy season. Ozonising by electric discharges though more expensive would be more constantly available.

In the Madras Presidency and probably in most other parts of India, the chemical features of drinking water cannot be ignored, and the methods of chemical examination stand greatly in need of modernising. So far these methods have been taken over in their entirety from English routine methods, but where the question of continuity of records has no very great force, as in India, the best methods should be substituted. It can hardly be seriously contended that methods such as those of Wanklyn and Tidy are the best.

At present results are reported as so many parts per 100,000 and there does not appear to be any sufficient reason for this. It rather suggests an unreasoned admiration for the metric system, as a system, without any other definite object in view. If results were reported as parts per million, that is, milligrams per litre, we have at once a relationship that is suggestive and easily made objective. Otherwise it might be better to go back to the old fashioned grains per gallon. It can hardly be maintained that 100 cubic centimetres is an inherently better volume of water to estimate substances in than 70 cubic centimetres, the miniature gallon of Wanklyn. Certain of the determinations, *e.g.*, albuminoid nitrogen and Total Solids should be made in the water as drawn and also after sedimentation. In this way we would get an insight into the quality of the suspended organic matter which would yield useful information as to the condition of gathering grounds, and as to the amount of dissolved salts other than those estimated under hardness and chlorine. Many of the Madras waters contain an amount of alkaline sulphate which approximates to that contained in medicinal mineral waters.

Chlorine is usually estimated by Mohr's Chromate of Silver method. This is a direct method and always gives too high results, as it takes a certain amount of silver to show up with the indicator. An allowance is usually made for this, but it would be preferable to combine it with Volkhart's method. In this process excess of silver is added to the water and the excess is estimated by titration against a volumetric solution of sulphocyanide of ammonium with ferric chloride as indicator. Here again it takes some volumetric solution to show up with the indicator and as a result too much silver is deducted from the amount originally added and too low a result is got. The mean of the two results would probably be correct.

Free ammonia should be estimated in successive 50 c. c. portions of the distillate as it comes over, until no more is got. The methods for estimating albuminoid nitrogen and oxidisable matter with hot alkaline and with acid solutions of permanganate of potash are thoroughly unsatisfactory. It can readily be shown that the former never gives a complete result, by cooling down and distilling off portions on successive days. Each day, although the process had apparently come to an end on the previous day, fresh quantities of ammonia will be found. By the use of more accurate methods we know now that Wanklyn's method as usually carried out rarely gives 50 per cent of the organic nitrogen present.

Tidy's method for oxygen is equally inaccurate and no two independent workers are likely to get the same result. The ratio of nitrogen to carbon is a very important one, as we can tell thereby whether the organic matter present in the water is of animal or vegetable origin. In recent reports I have been in the habit of taking the ratio of the figures for albuminoid nitrogen and oxygen absorbed, as an approximation to this N/C ratio, but it is not satisfactory and fluctuates within much wider limits than are got when the nitrogen and the carbon are accurately determined. I have got ratios as high as 1-2, which

could hardly point to anything else in the water than urea, whereas a ratio as low as 1·45 corresponds to some quite unknown form of organic matter occurring naturally in water.

In 1883 Kjeldahl[5] introduced his method for the estimation of nitrogen in organic substances and from its reliability and simplicity it rapidly came into favour. A few years later this method was employed in the estimation of albuminoid nitrogen in potable waters, and in 1889 Messrs. Drown and Martin[6] in America published the results got with 91 surface waters analysed by Wanklyn's and Kjeldahl's methods, respectively. The average amount of albuminoid ammonia (Wanklyn) per 100,000 parts was 0·0224, whereas by Kjeldahl the average amount was 0·0496 or more than twice as much A method which only reveals half or less than half of the substance estimated, obviously leaves much to be desired. In 1892 Professor Hunter Stewart[7] further extended the usefulness of the Kjeldahl method by estimating the amount of carbonic acid given off in the reaction and on applying this procedure to potable waters was able to arrive directly at the nitrogen-carbon ratio the importance of which was pointed out above. It is this method that I would propose to substitute for the two older processes of Wanklyn and Tidy. Comparative estimations of organic matter by Hunter Stewart's and Tidy's methods have not I think been carried out, but an examination of figures got by the former for organic carbon would lead to the belief that Tidy's method does not oxidise the carbon at all, and that only a portion of the hydrogen in the organic matter is oxidised. The oxygen absorbed by Tidy's method is not as a rule more than 1/10 of the carbon shown by Hunter Stewart's process. The method requires a rather more elaborate apparatus than either of the ones it is proposed to displace by it, and some little practice will be required before it can be carried out with skill and confidence, but there is nothing about it that any analyst accustomed to water analysis, need be anxious about. The quantity of water examined is 500 c. c. and the results may be doubled and reported as parts per million or divided by five and reported as parts per 100,000.

Five hundred c. c. of water are placed in a special hard glass flask with a long narrow neck and may be simply evaporated down or the first 200 c. c. may be distilled off and the free ammonia estimated in the distillate; according to circumstances a little caustic alkali may be added as usual. A preliminary test for nitrates is made in another portion of the water, and if these are present in excess (more than 0·7 parts N_2O_5 per 100,000) some pure ferrous sulphate prepared in a special manner must be added. Evaporation is continued until only 15 c. c. are left. If no nitrates, or less than the above amount are found, the ferrous sulphate is replaced by 3 c. c. of dilute sulphuric acid, and the evaporation carried on as usual. During this stage carbonic acid from carbonates is got rid of, but no decomposition of organic matter takes place. The flask is now connected up with an apparatus for delivering dry carbonic acid free air, and with the absorption apparatus containing reagents, acid permanganate of potash solution and a solution or suspension of barium and silver chromate in dilute chromic acid, for the purpose of destroying the sulphurous acid produced in the reaction and of retaining any hydrochloric or sulphuric acid that may be carried over. Dry carbonic acid free air is now sucked through the system for half an hour to expel any carbonic acid gas that may be in it. Then special tubes containing standardised baryta solution are inserted between the absorption tubes and the aspirator, and 10 c. c. of strong sulphuric acid is run into the flask from the side bulb on the air current tube. By means of suitable clips the carbonic acid free air, drawn in by the aspirator, is deflected so as not to pass into the flask. If air were sucked through the flask while heating was going on, sulphuric acid would be carried over and possibly attack the rubber stopper; as it is any sulphuric acid that may be vaporised, and care must be taken that this is not excessive, condenses on the sides and long neck of the flask. The flame is adjusted so that when the remaining water has been boiled off the residual sulphuric acid just does not boil. According to the amount of organic matter present in the water the reaction will be completed in two hours or less and the sulphuric acid in the flask will become quite colourless. The flame is now removed, and the current of air strengthened slightly to prevent backward suction as the flask cools. When the flask is cool, carbonic acid free air is again sucked for half an hour through the entire system including the flask

and the baryta tubes. The baryta tubes are now disconnected (after stopping the air current) and their contents are transferred under special precautions to well stoppered bottles, where the carbonate of barium produced in the analysis is allowed to settle. Portions of the baryta are then titrated against standardised acid and the difference of the titre represents the CO^2 produced from the organic matter. The contents of the flask are now diluted and made frankly alkaline and the ammonia distilled off and estimated by Nessler's reagent. To prevent bumping it is convenient to carry out this distillation in a current of steam got from redistilled boiling water. Throughout precautions must be taken to use reagents free from ammonia, and as sulphuric acid always contains a trace, the amount must be estimated and allowed for. Such precautions are however common to all forms of analysis. By this method then it is possible to determine the free ammonia, the organic ammonia and the organic carbon all in one portion of the water, and without ever having to transfer the contents of the flask into another vessel. This is a great advantage when we are dealing with milligrams of material, as a very small amount lost would involve a big percentage difference. I do not think that any other method for the estimation of organic matter in water, sewage, etc., possesses so many advantages and such freedom from defects as does this one.

There is not much to say about nitrates and nitrites. The one indicates that oxidation of the organic matter has taken place in part at least, the other that oxidation is still going on. In the former case we can hardly tell whether the nitrates have been derived from pollution added to the water and then oxidised, or in consequence of the water having traversed strata containing oxidised organic matter. Probably the former is the commoner, as it is comparatively rare to find any considerable quantity of organic matter along with a high figure for nitric nitrogen. Still this latter state of affairs does occur, and then it seems more likely that the water has picked up the nitrates directly. Nitrites are not often seen in Madras water, and the method for estimating them is not very satisfactory. As a rule sulphates are only tested for qualitatively, but I think a quantitative test should also be made when there is much more than a trace present. Possibly some rough opacity test after the addition of excess of barium chloride could be devised so as to give an indication whether the quantitative estimate should be proceeded with.

Finally there is the question of nomenclature, and there can be no question but that uniformity is desirable here. In water analysis the results are usually reported as so many parts of anhydrous base or acid in the volume of water selected, and I think that system should be consistently followed. Why hardness should be expressed in terms of calcium carbonate rather than in terms of calcium oxide I do not know. Again nitrates are reported as nitric anhydride ; why should unoxidised nitrogen be reported as such and not as ammonia (NH_3). The so-called free ammonia is present as ammonia or as salts of ammonia and the combined nitrogen is certainly very much nearer to ammonia than to nitrogen. Chlorides form a difficulty in this system ; so it would be even more consistent to report in terms of acid and basic radicles, but the introduction of hypothetical bodies such as SO_4 and NO_3 might be objected to.

The interpretation of results, in such a manner that they can be correlated and compared, would, I think, be useful and with that end in view I have drawn up the following table which is divided into three sections. It is based on the idea that from the analytical point of view, distilled water is the best water that can be got and that the various foreign bodies found in a water may be classified according to their undesirability and their quantity. It is of course purely artificial and differences of opinion are almost certain to occur as to the penal values given to different features. If the idea were considered sufficiently valuable, these differences could be readily overcome. The scale is of course drawn up with reference to current methods and would have to be modified if some of the suggestions I have put forward in the above paper were adopted. A great advantage of some such scheme would be that it would enable the quality of a water to be plotted graphically, so that an inspecting officer could see at a glance when any particular departure from the normal took place, and investigate its causes without the delay of looking over and comparing files of reports.

Section No. of Heading.	Penalty.	Maximum marks per heading.	Maximum marks per section.	Remarks.
1. Colour—				
Yellow	1	...	...	
Brown	2	2	...	
2. Opacity—				
Hazy	1	...	...	
Turbid	2	2	...	
3. Smell—	3	3	...	
4. Total Solids—				
10 30	1	...	...	
30 50	2	...	...	
50 100	3	...	...	
100 150	4	...	...	
150 200	5	5	...	
I. Total solids less combined hardness and chlorine.	...	...	...	In the case of unfiltered water deduct here any penalty given under opacity.
5. Sol: Sulphates—				
20	1	...	...	
20 40	2	...	...	
over 40	3	3	...	
6. Hardness Total	...	...	32	
over 10	1	...	...	
„ 20	2	...	...	
„ 40	3	...	...	
„ 60	4	...	...	
„ 100	5	...	...	
„ 150	6	6	...	
7. Hardness—				
Mainly permanent	6	...	...	
Over ½ permanent	5	...	...	Only penalised if total hardness over 10.
Less than ½ permanent ...	3	6	...	
Less than ¼ permanent ...	2	...	...	
Mainly temporary	1	...	...	
8. Chlorine—				
0·5 0·75	1	...	...	Only in the presence of a considerable quantity of organic matter.
0·75 1·0	2	...	...	
1·0 1·5	3	5	...	
1·5 2·0	4	...	...	
2·0 3·0	5	...	...	

Section No. of Heading.				Penalty.	Maximum marks per heading.	Maximum marks per section.	Remarks.
9. Chlorine—							
20	50	...	...	1	...	...	In absence of a considerable quantity of organic matter.
50	100	...	...	2	(2)	...	
10. Ammon. Nitrogen—							
Nil or Trace		...	...	0	......	......	
	0·002	...	...	1	......	......	
0·002	0·005	...	...	2	......	......	
0·005	0·010	...	...	3	7	......	
0·010	0·015	...	...	4	......	......	
0·015	0·020	...	...	5	......	......	
0·020	0·030	...	...	6	......	......	
0·030	0·050	...	...	7	......	......	
11. Album. Nitrogen—							
Nil or Trace		...	...	0	......	......	
under	0·005	...	...	1	......	......	
0·005	0·010	...	...	2	......	......	
0·010	0·020	...	...	3	......	......	
0·020	0·040	...	...	4	7	24	
0·040	0·080	...	...	5	......	......	
0·080	0·120	...	...	6	......	......	
0·120	0·200	...	...	7	......	......	
II. 12. Oxygen absorbed—							
0·020	0·050	...	...	1	......	......	
0·050	0·100	...	...	2	......	......	
0·100	0·200	...	...	3	5	......	
0·200	0·400	...	...	4	......	......	
0·400	0·800	...	...	5	......	......	
13. Nitrates and Nitrites		...	...	Not penalised	......	......	
14. Ratio of Album. Nitrogen to Oxy. absorbed—				......	......	......	
Richness of Nitro. in Organic matter.				......	......	......	Only if Oxygen absorbed is over 0·020.
1·3 or more		...	...	5	......	......	
Under 1·3 over 1·5		...	...	4	......	......	
„ 1·5 „ 1·8		...	...	2	5	......	
„ 1·8 „ 1·10		...	...	1	......	......	
Under 1·10		...	...	0	......	......	

Section No. of Heading.	Penalty.	Maximum marks per heading.	Maximum marks per section.	Remarks.
15. Total count—	......	......	......	......
Under 50	0	......	......	......
50 100	1	......	......	......
100 500	2	......	......	......
500 1,000	3	......	......	......
1,000 5,000	4	6	......	......
5,000 10,000	5	......	......	......
Over 10,000	6	......	......	......
16. Lactose Fermenters—				
Not present in 60 c. c. ...	0	......	......	......
Present in 60 c. c. ...	1	......	......	......
„ 20 c. c. ...	2	......	......	......
„ 10 c. c. ...	3	......	......	......
„ 5 c. c. ...	4	20	......	......
„ 1 c. c. ...	8	......	......	......
„ 0·1 c. c. ...	12	......	......	......
„ 0·01 c. c. ...	20	......	......	......
III.	......	......	44	......
17. Admixture of—				
Species in the Lactose Fermenters.				
More than 3	2	4	......	......
More than 5	4	......	......	......
18. Presence or absence of the various classes—				
All three present	10	......	......	......
Classes I and II	8	......	......	......
Classes I and III	7	......	......	......
Class I only	6	10	......	......
Classes II and III	4	......	......	......
Class II only	2	......	......	......
Class III only	1	......	......	......
19. Sporogenes 20 c. c. ...	......	......	......	......
Vibrios in 100 c. c. ...	......	4	......	......
Streptococci in 20 c. c. ...	......	......	......	......

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ALL-INDIA SANAITARY CONFERENCE—MADRAS—NOVEMBER 1912.

BACTERIOLOGICAL EXAMINATION OF WATER.

By

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At the last meeting of the British Medical Association a resolution to this effect was carried:—

> "That this conjoint meeting of the Sections of State Medicine and Bacteriology unanimously desires strongly to urge that no opinion as to the quality of a water for dietetic purposes should be arrived at on bacteriological evidence, without a local and topographical inspection of the sources of the supply, made by a competent observer."

This reads rather like a negation of the value of bacteriological findings, but I take it as meaning this.—The bacteriologist's report is by no means absolute, and the findings are for the most part always qualified. It would be therefore unwarranted to recommend anything in the nature of large expenditure on the basis of such a report alone. This, however, does not by any means imply, that the report is of no value.

The functions of the bacteriologist in relation to the examination of water supplies might be set down as:—

(1) Confirming the views formed upon an inspection of the locality of a source of water supply.

(2) Furnishing an independent opinion on the characteristics of a proposed or already existing water supply.

(3) Controlling the effectiveness of operations designed to free a water supply from pathogenic bacteria. This is, I think, a comparatively modest and yet not unsound estimate of the bacteriologist's functions in relation to the subject.

His method of examination may be described as:—

I. General. The number of colonies which develop after insemination of a nutrient medium with measured quantities of the test water is computed.

(a) on gelatine (b) on agar.

II. Special. (1) a determination is made of the smallest quantity of test water which still shows lactose fermenting and gas producing organisms in a nutrient medium containing bile salt.

(2) The presence of typical B. Coli in minimal quantities is estimated.

Not a great deal of stress is, as a rule, laid upon the total count as it is called. Attention is, therefore, mainly concentrated on the detection of B Coli, and especially of typical B. Coli as an indicator of pollution. Houston justifies this criterion on the grounds that:—

(1) B. Coli is superabundant in excremental matters;

(2) it is absent or present only in comparatively small numbers in water free from undesirable pollution;

(3) it is a decadent microbe when divorced from the animal body and therefore the presence of the typical organism in any quantity may be taken as evidence of recent and not remote pollution.

The technique of the detection of B. Coli has been reduced to one of great simplicity, and no bacteriologist would nowadays think of omitting the B. Coli test from his examination. It constitutes by far the most important of all the tests he can apply. But we may be pardoned for thinking, that, with the settlement of this technique, the last word has been said upon the subject of bacteriological water examination. Nor is it likely that this would be the opinion of the author who has done so much to define procedure in this matter. The very terms in which the final resolution at the British Medical Association were couched is itself sufficient to show this.

Now human excrement undoubtedly contains typical B. Coli in great excess, whilst the coliform organisms with their habitat in air, soil and water seem to present considerable variations from type. But human excrement is not the only excrement that contains B Coli in excess. In fact it is present, we may judge in this degree in all animal excrement. Thus whilst admittiug all the cogency of the arguments in favour of the sufficiency of the typical B. Coli test for the bacteriologist, there would seem to be no objection to an attempt to broaden the basis upon which a judgment of excremental pollution is formed. One objection which might even be raised to the method of test itself is, that it permits of no direct estimate of the number of typical B. Coli in the test water itself. The only tests which are of this direct nature are the "total number" tests, and the "Lactose fermentation-gas production" tests. For the typical B. Coli test sub-cultures are made from the incubated lactose-bile salt media. But by incubation in such a medium with its highly favouring action to the growth of particular strains of organisms, and its inhibition of the growth of others, all trace of original proportions must be lost. The method as it stands is certainly a time saving procedure. But it seems to me that there is argument which can be adduced for investigation into the bacterial flora of water as a whole; its variation with season and circumstance, and the correlation, if any, which exists between the preponderant presence of particular species and the goodness or badness of water.

It is reasonable to suppose that with the entrance into water,or extraction therefrom, of differing chemical substances such as supply nutriment to bacteria, the original flora may come to show concomitant variations. Careful work under known conditions might serve to differentiate the groupings due to growth in a fæcally contaminated water, from that contaminated rather with urine, or merely with organic vegetable matter.

The method suggested here is not that of proceeding to condemnation in terms of contained known noxious organisms or their allies, but from the grouping of types found in known good or bad waters to the goodness or badness of the sample under test. Such a method necessitates the elaboration of standards; standards of great variety as regards the form of supply and the circumstances of examination. But such standards are, at least for India, only in process of making even by the usual procedure. Time and special experiment would show whether the labour involved in generalising our enquiry into the flora of potable waters would be superfluous or not.

My work during the past nine months has consisted in an endeavour to erect one standard of comparison in the shape of a complete characterisation of a water of accepted purity and of definite type. The investigation in order to be complete will extend over a whole twelve months; but the results already obtained, and the detail of the investigation may be of interest to this conference.

There are special advantages too, which attach to an exhaustive investigation of this sort having reference to the laboratory water supply. A sample from this supply may always be used alongside a test sample and so serve to some extent as an eliminant of variations due to accidental causes such as variations in composition of media, alterations in technique, and so on. The selection of the characters to which special significance should be given will depend on their constancy or their variability, and the degree to which any given character varies simply concurrently with another, or independently of it. We might investigate such characters, in the undifferentiated flora of a given water as the proportions of liquefying or nonliquefying organisms, spore bearing or non-spore bearing,

cocci, bacilli and vibrios, and special subdivisional forms of these, motile and non-motile, organisms easily or not easily destroyed by physical and chemical agencies, such as heat, sunlight, desiccation, antiseptics and so on. So also with sugar fermentations we might expect to obtain certain groupings amongst these reactions in the different groups of waters. Many other characters than these mentioned might be taken into consideration, nor need they be only alternative. Special tests to give quantitative grading might be still more effective for differentiation than the simple binary division. The effect of season and of the conditions which go to make up seasonal character would have to be carefully gone into as also would the nearness or remoteness in time of cause and effect. On this conception then, what we have to determine is the correlation between the differential characters of the flora of waters and their potability. It is but a step further although by no means a necessary step to give names to the individual bacteria composing the groups differentiated under this scheme. I may point out, however, that I myself have particularly avoided any attempt to name the bacteria isolated.

The method of investigation which I have outlined would be applicable to the comparison of potable waters under all the possible conditions under which they are found, as well as to the comparison of the state of an unknown water with that of known waters. Thus we could compare the characterisation (using this term as the sum total of characters) of a water before and after storage, before and after filtration, well with river, upland surface with well and river water and so on.

My own investigation consists simply of a characterisation of a known good water—the Kasauli water—and not of a comparison. Thus it represents more a suggestion as to method than an idea carried to a conclusion. My opportunities for making comparisons were very limited.

Kasauli is situated in the lower Himilayas Lat.—30° 58′ Long. 77°—2′. The spring from which its water supply is derived is situated on the southern aspect of the ridge at an elevation above sea level of 5,100 feet. Here it gushes out of the hill side under great pressure, and gives one the impression, considering the steepness and isolation of the ridge, that its gathering ground must be placed at some considerable distance within the hills. The water is pumped from this spot some 1,000 feet to reservoirs in the station from which it finds its way by gravitation to stand pipes at different levels. The following are certain details regarding the rainfall as recorded at Kasauli, and the delivery in gallons throughout the year :—

TABLE I.

Frequency distribution of rainfall in Kasauli from 1st January to 30th September 1912 in inches reckoned for each 24 hours.

Under	·05,	·05,	·1,	·5,	1·0,	1·5,	2·0,	2·5,	3·0,	3·5,	4·0 inches.
	196,	12,	16,	28,	8,	6,	4,	2,	1,	0,	1 days.

TABLE II.

Average rainfall in inches per month from 1st January to 30th September 1912.

January	...	...	...	...	2·32 inches.
February	...	...	...	...	1·31 ,,
March	...	...	...	...	1·18 ,,
April	...	...	...	...	1·46 ,,
May	...	...	...	...	0·38 ,,
June	...	...	...	...	2·17 ,,
July	...	...	...	...	16·48 ,,
August	...	...	...	...	18·66 ,,

TABLE III.

Average daily yield of spring in gallons, from 1st January to 30th September 1912.

January	56,712	Gallons.
February	47,381	"
March	42,339	"
April	41,279	"
May	40,426	"
June	35,879	"
July	38,631	"
August	245,489	"
September	356,400	"

TABLE IV.

Average daily amount of water pumped up from the spring in gallons, from 1st January to 30th September 1912.

January	36,480	Gallons.
February	26,408	"
March	30,440	"
April	35,575	"
May	43,241	"
June	37,725	"
July	40,233	"
August	48,608	"
September	47,926	"

Before proceeding to the actual results obtained I may here give brief details of the technique employed.

As far as possible a daily sample is taken of the laboratory tap water. The water is allowed to flow for 3 minutes before collecting the sample in a sterile flask. The water in the flask is then well shaken and the following tests carried out :—

(1) *Total count on Agar.* ·5 and 1 c. c. of the water are taken respectively and put into 2 sterile petri dishes. 10 c. c. of agar, liquified and cooled to 42°C is poured into each plate. These plates are incubated at 37°C for 48 hours and all colonies which develop are recorded.

The quantity of agar used in the medium is 2 per cent and it has an acidity of *plus* 10 to phenolphthalein.

(2) *Total count on Gelatine.* The same quantities of water, *viz.* ·5 and 1 c. c. are placed in 2 gelatine tubes each containing 10 c. c. of the medium. These are liquified at 30°C and poured into sterile petri dishes. The dishes are

incubated at 18° to 20°C for 48 hours and the number of colonies recorded. This medium contains 12 per cent. of gelatine and has an acidity of *plus* 10 to phenolphthalein. For this purpose a Hearson's cool incubator was used which kept the temperature between 18°C to 21°C.

From these plates the next count was made, *viz.*:

(3) *Total count of Gelatine liquifiers.*

(4) *Presumptive B. Coli test.* To tubes containing MacConkey's neutral red, bile salt, lactose, peptone broth, the following quantities of water are added :—(1) 100 c. c, (2) 10 c. c, (3) 1 c c., and (4) ·1 c. c. These tubes are incubated at 37°C for 48 hours, and those showing both acid and gas are recorded as positive. 50 c. c of a triple strength broth is placed in the tube to contain 100 c. c. of water, and 10 c. c. of a double strength broth in the tube to contain 10 c. c of water.

(5) *Total count of Lactose Fermenters.* 10 c. c of the water is placed in a large petri dish and 30 c. c of a neutral red bile salt, peptone, lactose, agar poured over it The plate is incubated at 37°C for 48 hours and the number of red colonies which develop are counted.

(6) To get an idea of the *General flora* of the water it was thought advisable to take colonies which develop on ordinary agar. In this medium the majority of organisms will grow. A full investigation would have to take into account the organisms which grow at other temperatures than 37°C.

From one of the plates from which the total agar count is taken 10 unselected colonies are fished out, and put through the following tests :—

(*a*) Morphological characters—size, shape, motility, gram staining.

(*b*) The production of acid and gas in a Lactose Medium.

„ „ „ „ Glucose „

„ „ „ „ Dulcite „

„ „ „ „ Inulin „

„ „ „ „ Adonit „

(*c*) Indol test.

(*d*) Voges and Proska reaction.

The medium used for the sugar reactions is a gelatine one as used Houston, in small tubes $2\frac{1}{2}'' \times \frac{1}{4}''$. The actual sugars used are those recommended by MacConkey.

The following tables give the results of the investigation so far as it has yet been carried. I simply give the facts but withhold my deductions for the present :—

TABLE V.

Frequency distribution of the total count on gelatine.

Under 10	10	20	30	40	50	60	70	80	90	100	110	120	130	Colonies.
0	0	1	14	35	47	37	42	19	13	4	5	3	0	=220

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Table VI.

Frequency distribution of the total count on agar.

Under 10	10	20	30	40	50	60	70	80	90	100	110	120		Colonies.
5	19	31	50	42	32	19	11	5	2	3	1	0	=	220

Table VII.

Average total counts on gelatine and agar by months.

——	Gelatine.	Agar.	No. of samples.
January	50	10	22
February	71	48	20
March	78	47	21
April	62	44	26
May	77	52	28
June	72	58	26
July	48	30	30
August	49	29	28
September	43	27	19

In tables V, VI and VII the number of colonies recorded are per c. c. of water.

Table VIII.

Correlation of total counts on gelatine and Agar.

No. of colonies per c.c. of water on gelatine.

No. of colonies per c.c. of water on agar.	0	10	20	30	40	50	60	70	80	90	100	110	120	
0	..	...	...	1	...	2	2	...	...	...	...	..	...	5
10	...	...	1	2	1	7	2	6	...	...		...	...	19
20	...	...	...	6	15	9	1	...	...	...	...	...	...	31
30	...	...	...	3	15	16	8	7	1	...	...	...	...	50
40	...	...	...	2	3	10	13	10	2	2	...	...	...	42
50	...	...	...	...	1	1	9	13	5	2	1	...	...	32
60	...	...	...	...	...	...	1	3	9	5	1	...	...	19
70	...	...	...	...	...	1	1	2	2	2	2	1	...	11
80	...	...	...	...	...	...	.	...	...	1	...	3	1	5
90	...	...	...	...	...	1	...	...	...	...	...	...	1	2
100	...	...	...	...	...	...	...	1	...	...	...	1	1	3
110	...	...	...	...	...	...	...	...	...	1	...	...	...	1
120	...	...	...	...	...	...	...	...	...	...	...	...	...	
	...	...	1	14	35	47	37	42	19	13	4	5	3	220

Table IX.

Correlation of total count on gelatine and Temperature in the shade, taken at time of withdrawal of sample 10 to 11 A.M.

No. of colonies per c.c. of water on gelatine.

		0	10	20	30	40	50	60	70	80	90	100	110	120	
Temperature in shade.	45	...	...	...	...	...	...	...	...	...	...	...	...	...	0
	50	...	...	...	3	1	3	3	5	1	...	...	...	...	16
	55	..	...	...	3	2	6	5	9	3	3	...	1	...	32
	60	...	...	...	...	1	3	2	3	2	...	1	1	...	13
	65	...	..	...	1	4	4	3	1	1	4	1	...	...	19
	70	...	...	...	6	21	18	6	6	1	1	1	...	...	60
	75	...	...	1	1	5	11	8	5	3	...	...	1	...	35
	80	...	...	...	...	1	2	9	11	6	3	...	1	1	34
	85	...	...	...	...	...	...	1	2	2	2	1	1	2	11
		...	...	1	14	35	47	37	42	19	13	4	5	3	220

Table X.

Correlation of total count on gelatine and rainfall :—

		Number of Colonies per c.c. of water on gelatine.													
		0	10	20	30	40	50	60	70	80	90	100	110	120	
Rainfall in inches	0	...	...	1	6	18	26	26	31	17	10	3	5	3	146
	·05	...	...	...	...	3	5	3	3	1	...	1	...	...	16
	·1	...	...	...	3	1	2	2	5	1	...	..	...	...	14
	·5	...	...	...	3	6	6	3	3	..	3	...	...	...	24
	1	...	...	...	...	2	1	2	...	...	...	..	...	...	5
	1·5	...	...	...	1	3	2	1	...	...	...	...	.	...	7
	2	...	...	...	...	1	2	...	...	...	...	...	...	...	3
	2·5	...	...	...	...	...	3	...	...	...	...	...	...	...	3
	3	...	...	...	...	1	...	...	...	...	...	...	...	...	1
	3·5	...	...	...	...	...	...	...	...	...	...	...	...	...	0
	4	...	...	...	1	...	...	...	...	...	...	...	...	...	1
Total ...	...	0	0	1	14	35	47	37	42	19	13	4	5	3	220

Table XI.

Constancy of the presumptive B. Coli test by months :—

—	− 100.	+ 100.	+ 10	+ 1	+ ·1	C.C.	Number of samples.
January	0	7	15	0	0	...	22
February ...	0	2	18	0	0	...	20
March	1	8	12	0	0	...	21
April	3	5	17	1	0	...	26
May	3	15	9	1	0	...	28
June	1	7	16	2	0	...	26
July	0	2	26	2	0	...	30
August	1	8	17	2	0	...	28
September ...	1	7	11	0	0	...	19
Total ...	10	61	141	8	0	...	220

N. B. + indicates a positive result giving both acid and gas.

— indicates a negative result.

The 10 samples which were negative in 100 c.c. of water, might have been positive, if large quantities of water had been tested.

Table XII.

Giving morphological characters of organisms isolated in numbers during the four months March, April, May and June 1912 :—

COCCI.									BACILLI.					VIBRIOS
Large.			Medium.			Small			Non-spore bearing.				Spore bearing.	
									Long.		Short.			
Staph.	Strep.	Diplo.	Staph.	Strep.	Diplo.	Staph.	Strep.	Diplo.	Thick.	Thin.	Thick.	Thin.		
0	1	23	90	19	0	10	3	0	22	17	129	3	65	17

Total colonies isolated = 399.

Time has not permitted to give other characters of the organisms isolated, nor to add to the above list the organisms isolated during July, August and September.

Isolation of typical B. Coli.

This was not carried out as part of the daily test. But an endeavour was made to isolate the typical B. Coli on 20 different occasions from samples in which the presumptive B. Coli was positive in 10 c.c. On no occasion was a typical B. Coli isolated.

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

THE EXAMINATION OF SAMPLES OF WATER SENT TO A DISTANT LABORATORY.

BY

Military Assistant Surgeon E. C. R. Fox, Assistant to the Director, Pasteur Institute, Kasauli.

It has always been difficult to carry out a satisfactory bacteriological examination of a water at this laboratory owing to the fact that elaborate precautions to prevent multiplication of organisms had to be taken if the finding was to be of any value. Ice was used to maintain a low temperature, but very often the ice had completely melted before arrival of the sample, and no examination that could be carried out was likely to be satisfactory.

Remlinger in the *Compte Rendus Societe de Boilogie* No. 2, No. 9 and No. 12 of 1911, gave a method simple and to all appearances perfectly effective by which the difficulty could be overcome. He added salt in certain proportions to samples, and maintained that the original flora of the water was preserved thereby without alteration from death, or multiplication.

I have further investigated the point, and whilst confirming Remlinger's statements in general, I have found certain important differences with regard to quantities recommended and the media to be used. I found in the first place that the proportion of salt recommended was differentiating in respect to organism capable of growing at incubation temperature of 37°C. and 22°C., respectively. Therefore while I consider that the method is useful for the purpose stated, variations of the method are required for the purpose of certain determinations. Roughly speaking I determined that a 6 per cent proportion was suitable for organisms growing on Agar at 37°C., whereas a concentration greater than 3 per cent produced a very marked effect on organisms growing on Gelatine at 22°C. A salting at 3 per cent on the other hand, did not preserve the original state for organisms growing on Agar at 37°C—they multiplied rapidly in spite of this addition of salt. Therefore it would seem advisable in despatching samples for examination to a laboratory, where both counts are desired, to send them salted at 3 per cent and at 6 per cent.

The results of these examinations of Kasauli water were as follows :—

EXPERIMENT I.

Sample of water salted at 5 per cent and kept at room temperature—62—65°Fr. Count taken after 48 hours incubation—

——	Count on Gelatine.	Count on Agar.
At time of taking sample	58 per c.c. ...	43 per c.c.
24 hours after taking sample	63 " ...	49 "
48 ditto	12 " ...	87 "
72 ditto	4 " ...	Overcrowded.

The table shows that salting at 5 per cent allows the multiplication of organisms growing on Agar at 37°C. after standing 24 hours, and causes the reduction in numbers of those organisms growing on Gelatine at 22°C.

Experiment II.

Samples of water salted at 6 per cent and kept at room temperature 62—65°Fr Count taken after 48 hours incubation—

—				On Gelatine.	On Agar.
At time of taking sample	...	...	...	38	28
24 hours after taking sample	...	...	...	6	25
48 ditto	...	...	...	7	23
72 ditto	...	...	...	5	24
96 ditto	...	...	...	0	26

Experiment III.

Sample of water salted at 3 per cent and kept at room temperature 62—65° Fr. Count taken after 48 hours incubation—

—				On Gelatine.	On Agar.
At time of taking sample	...	...	...	67	48
24 hours after taking sample	...	...	...	58	128
48 ditto	...	...	...	62	Overcrowded.
72 ditto	...	...	...	54	„
96 ditto	...	...	...	48	„

Experiment IV.

This table shows an experiment with varying quantities of salt concentration. The total count on Agar only is shown. Samples kept at room temperature 70—75°Fr.

—	0.	2 per cent.	4 per cent.	6 per cent.	8 per cent.	10 per cent.	Salt concentration.
0 hours ...	14	10	10	13	14	10	
24 „ ...	*O-C.	10	16	12	10	5	
48 „ ...	O-C.	30	22	12	8	7	
72 „ ...	O-C.	OC.	54	16	4	4	
96 „ ...	O-C.	OC.	83	14	6	4	
120 „ ...	O-C.	OC.	OC.	9	2	1	

* Overcrowded.

From this table we see that rapid multiplication of organisms took place in water kept at room temperature without any special addition. Two per cent salt seems able to preserve the original for 24 hours, but multiplication begins to be observed in 48 hours, and plates become overcrowded in 72 hours.

Six per cent salt gives the most constant results with little or no difference from the original count up to 120 hours.

Ten per cent salt causes apparently a direct reduction in the bacterial flora of a sample of water.

It might be found that different concentrations of salt may be needed for water sent from the plains where the temperature is considerably higher than the room temperature at the time that these experiments were carried out. Further work is being done to test this.

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PART V.

MISCELLANEOUS PAPERS ON HYGIENE.

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

THREE POPULAR ERRORS IN HYGIENE.

By

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The popular error. The general misapprehension or misinterpretation of ordinary facts,—is one of the real difficulties against which the scientific sanitarian has to struggle : the people are persuaded in error beforehand, and are not prepared to accept another, although a more logical, interpretation of the facts or circumstances.

A quasi-scientific confusion of facts and fancies characterises the condition, and produces an antagonistic state of mind, which scorns the truth, because it differs from the preconceived idea. Time worn dogmas, the relics of an ignorant and superstitious past, are still handed down from generation to generation as indisputable hygienic doctrines, approved by modern science. These are the real enemies of progress because they find ready acceptance and are not challenged, and because they satisfy the minds of the people and prevent the seeking after knowledge and the acceptance of real results which would otherwise take place.

I propose therefore to put forward and discuss some of the more common of such popular errors, to turn upon them the cold light of reason, and to endeavour to demonstrate their fallacies and prove their errors, by offering a more scientific and more probable explanation of the facts and circumstances associated with them.

1. The Folly of Boiling Water for Drinking Purposes.

2. The Important Factor in Change of Climate.

3. The Abuse and Waste of Disinfectants.

1. *The Folly of Boiling Water for drinking purposes.*—It is a common error to believe that the boiling of water is the safest way of making it potable. This theory is true enough up to a certain point but its scientific value is lost in the looseness of its application. If we consider that nearly all surface waters which are practically the only waters available in this country, contain a good deal, more than a trace of organic matter, much of which is living, and in their natural state swarm with bacteria, then we must be prepared to admit that the boiling of them is nothing more than the manufacture of a very dilute and sterile bouillon, than which there could be a no more generally useful medium for the cultivation of most organisms. The sterility of this medium obviously cannot and does not last, and the important practical question arises, which is the lucky organism that is to find priority and multiply in the medium? If the receptacles are in any way open to contamination,—and how many are not?—it is an obvious mathematical certainty that some of them must become contaminated with pathogenic organisms, which will rapidly multiply under such favourable conditions, and give rise to a serious risk of epidemic disease. If the medium could be kept sterile after being boiled there could be no objection to the procedure, but no one will, I think, be prepared to argue that there is any likelihood of the ordinary receptacle ever being kept sterile for any length of time.

The question then becomes one of the probability of infection with a pathogenic organism, and that will of course vary with the local conditions and circumstances in each case but the certainty of some pathogenic infections always remains.

My attention was first attracted to this question by my own experiences on tour. In camp I always carry a large water bottle, which is filled each morning with filtered water and I always find that the water remains sweet all day. On several occasions when my pump filter has been out of order I have had occasion to fill the bottle at night (after scalding it out) with boiling water, and let it cool for use in the morning, and on nearly every such occasion I have found that the water became putrid before evening. At first I did not think of what now appears to me to be the obvious explanation—that I had prepared a bouillon which was kept at a nice temperature all forenoon by the rays of the sun, and in which the first falling bacteria were going to flourish and multiply; but now I am only thankful that the conditions and circumstances were not such that the first-comer should have been a cholera vibrio or a Shiga's bacillus.

The action of a filter on the other hand tends to diminish the numbers of bacteria and living organisms to a small and harmless quantity and in so doing removes the greater part of the available pabulum, which makes it difficult for any organism to flourish and multiply in a short time because there is always a struggle for existence, a fight for the available food, going on between the few organisms left in the water and any others which may find their way into it.

2. *The Important Factor in Change of Climate.*—A general misapprehension is everywhere prevalent on the subject of climate. A change of air is frequently spoken of or prescribed by the European, and the Hindustani word for climate means water and air. It is therefore an obviously general idea that the variations in health produced by change of residence are largely attributed to the air, or the air and water of the place. Now the scientific mind cannot be satisfied with so obvious a fallacy. The variations in health occur, but there are no known variations of any magnitude or medicinal value in the composition of the atmosphere, and the differences in chemical constitution of ordinary waters are not generally such as to possess any medicinal properties.

In the light of recent research work done by Metchnikoff and others on the importance of the intestinal flora, it has occurred to me that the real factor of importance in "change" is the biological one,—that the intestinal flora become altered by the change of food and water-supply.

I do not in any way wish to argue against the importance of such factors as temperature and humidity, but I cannot believe that they alone offer a sufficient explanation of the often enormous variations produced in health by a mere change of residence. I offer this explanation as one which is both possible and probable, which is both intelligible and reasonable, and which is capable of supplying a full and satisfactory explanation of the observed facts.

3. *The Abuse and Waste of Disinfectants.*—No fallacy is more general and more deeply rooted than the perverted faith which is so prevalent in the absolute importance and efficacy of chemical disinfectants. This faith is a heritage from the scientific teaching of a previous generation, and takes its origin in the original work of Pasteur and Lister, but it applies the lessons taught by those masters in a manner peculiar to the mental processes which foster it and it refuses to be refuted or rejected.

In the course of my experience as a Sanitary Officer I have found it to be the invariable practice of civil and military officers of all ranks and of the educated Indian in general, to throw chemical disinfectants all round the place in the most lavish manner whenever any case of epidemic disease occurs.

In fact, the commonly accepted interpretation of the word sanitation seems to be " the use of chemical disinfectants", and the means usually adopted to prevent the spread of epidemics are those of wasting expensive bactericidal fluids.

The disinfecting fluids which are most commonly met with are Mercury salts, Carbolic acid, Phenyle, Cyllin, and other similar coal tar preparations.

The common property of these various bodies is a bactericidal power of varying intensity.

The purposes for which disinfectants are commonly used in this country are of two sorts, *viz.*, to disinfect excreta, property, and premises, in cases of epidemic disease, especially in plague and cholera, and to "disinfect" in a general manner, privies, drains, etc., from which disease or nuisance might or does arise.

These purposes are not fulfilled in any real sense of that word. The disinfection is a nominal one which creates a pleasant mental satisfaction and a sense of safety, but in the majority of cases it does not do very much more.

For example, the Plague Commission has elaborated, in a most careful and scientific manner, the propagation of human plague, and proved that the organism does not live for any length of time outside a host, and that the infection is really an inoculation and is not usually obtained by contact, nor ever in food or drink, or in the dust of roads and floors. Nevertheless it is still almost an invariable practice to disinfect infected premises and property with chemical disinfectants. It is only in the large towns where special trained men are employed that the attack is directed against the fleas in the house, and it is quite useless, as I have found by bitter experience, to advise against the use of bactericidal disinfectants.

Take again the circumstances and conditions found during a cholera epidemic. The excreta are admittedly the fount of infection, and they infect the clothing and premises, but I contend that the duration of that infection is a short one, and that the important period in its duration is that immediately following the excretion. The infection tends to die rapidly especially when exposed to sunlight, but the infection may, and often does, become conveyed to food or drink supplies by contact or by flies, before it has lost its vitality. The utility of disinfection therefore depends upon whether it forestalls any such conveyance, and obviously requires that it should be carried out immediately.

Now experience of cholera epidemics, both large and small, shows that the organisation of disinfection is generally centralised, and localised, at some more or less distant spot, and that reports have to pass through several hands before reaching the actual disinfecting staff : also this staff can only be in one place at once. It is therefore quite a usual experience to find that the disinfection is done next day and it is quite the exception to find that it is ever done within six hours.

Under such conditions, I maintain that disinfection is practically useless and is a mere waste of money in wages and disinfectants, and that the false sense of security engendered by it constitutes an added danger.

In the use of disinfecting fluids for the so-called "disinfection" of privies, drains, etc., there is a similar waste of materials, time and money. To begin with it is seldom a "disinfection", because in the vast majority of cases there is no "infection" to get rid of. The process is really one of arresting by chemical means the putrefactive disorganisation of sewage which is giving rise to offensive odours, and the method used is both expensive and futile.

In the experiences of many inspections, I have found that the use of such disinfectants is in direct proportion to the inefficiency of the conservancy arrangements, is called for because of such inefficiency and neglect, and is used as a cloak to cover these faults.

The result of such use of disinfectants is to arrest the putrefactive processes temporarily; but they cannot be permanently prevented and the existing nuisance is only transferred or postponed, whilst a fresh nuisance arises daily.

It would appear therefore that disinfectants cannot take the place of plain water and proper conservancy arrangements in the so-called disinfection of privies, drains, etc., and they serve no useful purpose in this connection, but tend rather to conceal and condone the defects of careless and neglected conservancy.

It would also appear that the use of disinfectants in epidemic disease is carried out on erroneous principles and in a foolish manner whereby a great economic waste is steadily maintained. I would even argue that the primitive practice of burning tar barrels and sulphur at street corners (a practice which is generally condemned as foolish by medical men) may serve a more useful purpose in cholera epidemics than the throwing about of disinfectants, because the tar barrels may burn all day and to some extent drive away the flies, which are the probable carriers and transmitters of infection whilst the disinfectants are generally applied to an infection which is already moribund or dead.

CONSERVANCY IN THE TROPICS AN IMPORTANT WORK OF THE HEALTH DEPARTMENT

BY

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Health Officer, Lahore, and Professor of Hygiene, Medical College, Lahore.

GENTLEMEN,

Medical research has shown how a large number of diseases from which man suffers are due to microbic life and transmissible by insects; and this is especially so in the tropics. Thus we find:

First.—That Enteric, Cholera, Dysentey and Diarrhœa are all filth diseases, are spread by flies, and, possibly to a limited extent, by dust. They are all filth diseases related to excreta, and where the water carriage system does not exist, the early and proper removal of all filth, etc., by conservancy methods is necessary.

Second.—Rubbish attracts rats and so aids the spread of Plague Plague I regard as a disease primarily of the sewer rat, and is transmitted by infection through fleas to the house rat, and so to man. Plague is thus a filth disease and the early and proper removal of rubbish, etc., from compounds does much to lower the chance of visits by rats, and therefore of plague infection.

Thirdly.—In flat places, like Lahore, storm water drains are simply elongated depressions in the ground, open to the air, with very little fall. In such, as the 'head' of water becomes little or nil, water stagnates; in such drains also sumps and cunettes are made which constantly have stagnant water in them. Such places become the breeding grounds of all kinds of mosquitoes, including *anopheles*. Stagnant water can only be regarded as filth water. In this sense malaria can be related as a filth disease, and the early and proper removal or disposal or treatment of such water is an important matter for public Health. In a water-logged city like Amritsar with such *kutcha* drains one can easily understand the prevalence of Malaria.

Fourthly.—Flies of all kinds and many other insects may be said to have their breeding places in filth, manure, cowdung, and in the débris of 'Rubbish,' and we know some diseases are transmitted by flies, phlebotomi, bedbugs, etc.; and probably other tropical diseases may be related to insects whose relation to them is at present unknown. The removal of such and their haunts, as far as is possible, is a preventive measure in public health administration.

Fifth.—Many intestinal parasitic diseases are transmitted from the lower animals to man. Besides *ankylostoma*, which is essentially a filth disease, all intestinal parasitic diseases cannot be excluded from such a designation; and the possibility of their presence in the filth accumulations from dogs, pigs, horses, cows, etc., is only another reason why such filth accumulations should be early removed and specially treated.

Sixth.—In congested cities like Lahore, and in congested villages, cowdung cakes are dried on the walls of houses and compounds, and the débris from these fall down into the narrow streets and *kuchas*. Thus comes into our consideration another disease which the more it is enquired into the greater seems its prevalence. I mean *phthisis*. The filthy dusty débris from these cakes is undoubtedly an irritating particle for inhalation; but this is not all. It has been definitely proved that the *Tubercle Bacillus* can be transmitted through the dung of infected cattle (in these cases the coughed up sputum is swallowed). But this unfortunately is not the only danger associated with them. It has also been proved that the dung of cows can contain the *Tubercle Bacillus* even though the animal shows no evidence of Tuberculosis of the lung. Thus Mohler

has found the germs of Tuberculosis in the manure of over 41 per cent of cows of healthy appearance which showed no evidence of tuberculosis save by the tuberculin test. Thus the dung of cattle is a source of infection of milk and also may become secondarily infected by the spitting habit of Indians on to walls. Is this dried cowdung cake distributing its dusty particle with the *Tubercle Bacillus* not a danger, especially in congested *kuchas* where we usually find it? Will any one here deny its potentiality in causing phthisis? In addition to this we usually find ill-ventilated and ill-lighted rooms with overcrowding and this gives to you an awful picture of the misery in such congested cities and villages. Is the early and proper removal of all dust in such *kuchas* not an important matter for the control of the Health Officer?

Seventh.—Let us consider village sanitation. Apart from the water supply what is the most important requisite to reduce mortality and upraise the stamina of the people? Undoubtedly conservancy. Trained Sanitary Inspectors or Assistant District Health Officers are required for the villages.

Eighth.—In addition we can safely say many diseases of infants are related to Conservancy. Infants are influenced much by the Sanitary condition of their environment.

If, gentlemen, you agree with me in these views do you not agree that the man who is most interested in the prevention of disease, reduction of deaths, and in the upraising of the stamina of the people should control the conservancy of roads, drains, latrines, and all open storm water channes? I consider it to be one of the most important duties of an Health Officer in the Tropics. Now, the reason why I thought I would make this matter a subject of a paper from me for this Congress is because I hold the view that with the Medical knowledge of the specialist (the Health Officer) the best results to the public Health should accrue from Conservancy being in his charge and because there is prevalent among some Engineers an idea that such should be under their charge. In this one thing I certainly think sanitation in the East differs from sanitation in the West. I regard the control of conservancy of roads, drains, latrines and open storm water channels under the control of Engineers as dangerous to the public Health as Engineers do not possess the knowledge of the relationship to diseases, do not view the matter with the same hygienic eye, so to speak,—and, since the Health Officer has first knowledge of the prevalence of any disease in a locality he can the more rapidly act and in the special manner he would like to. I do not think the Health Officer should be merely an adviser but rather an essential and active agent in the removal of nuisances and effecting cleanliness in the interests of public Health. I have no quarrel with Engineers and regard them as doing work of the utmost sanitary importance but in the matter of control of conservancy and the cleanliness of open storm water channels where the fall is not good I consider this to be an important duty of the Health department.

I have taken the trouble to find out from twenty-four Municipalities the existing control as to (1) Conservancy of roads, drains and latrines and (2) that of storm water channels. The Municipalities asked were: Mussoorie, Delhi, Simla, Meerut, Jubbulpore, Allahabad, Lucknow, Karachi, Bombay, Sukkur, Cawnpore, Nagpur, Darjeeling, Amritsar, Calcutta, Colombo, Bareilly, Ootacomund, Madras, Poona, Madura, Rangoon, Benares and Agra. Out of these it is pleasing here to record that as regards the first, only in Calcutta, Rangoon, and Colombo, is conservancy of roads, drains and latrines under the Engineering department. With reference to Calcutta I might add that at a recent discussion at the Corporation the existing system was regarded as unsatisfactory and a proposal was made to put all conservancy under a separate staff of medical men; and in this Calcutta would gain. At Ootacamund it is partly under the Health Officer and partly under the Engineer. In Darjeeling, where there is no Health Officer, conservancy is under the advice of the Civil Surgeon. As regards the second point, *i.e.*, of control of storm water channels, in ten Municipalities the control is under the Health Officer. At Sukkur and Darjeeling, both of which have no special Health Officer, the control is under the Sanitary Department, *i.e.*, I take under advise of the Civil Surgeon. At Delhi and Lahore the control is

divided between the Health Officer and Engineer (in Lahore the Health Officer looks after the surface contributary channels and the Engineer the large main storm escapes). At Nagpur and Amritsar (where all the channels are mostly *kutcha*) the control is under the Engineer (except in Amritsar the city main drain is under the Health Officer). At Karachi, Bombay, Calcutta, Colombo, Rangoon, Bareilly and Poona the storm channels are under the Engineer but in the case of the first five cities the channels are I understand entirely underground and have good falls and so do not come in 'my category *re* control. Thus you will see there is not entire agreement as to the question of control and whilst in the case of the Municipalities nearly all have put conservancy of roads, drains and latrines under the Health Officer there is a good divergency in the matter of control of the cleanliness of storm water channels. It is highly desirable that both the matters referred to in this paper should be treated as important matters of sanitation controllable by the Health Officer and if the Department of Education could see its way to issue advise to all Municipalities on this matter it would be a gain to the public Health.

I trust I have made the subject sufficiently interesting and its importance regarded as amply warranting its introduction.

Place.	Roads and drains and latrines.	Storm water drains.	REMARKS.
Mussoorie ...	Under H. O. ...	H. O.	
Delhi	H. O. ...	Partly H. O.	
Simla	H. O. ...	H. O.	
Meerut... ...	H. O. ...	H. O.	
Jubbulpore ...	H. O. ...	H. O.	
Allahabad ...	H. O. ...	H. O.	
Lucknow ...	H. O. ...	H. O. ...	New scheme.
Karachi ...	H. O. ...	M. E.	
Bombay ...	H. O. ...	M. E.	
Sukkur ...	Under Sany. Deptt. (No H. O.)	Under Sany. Deptt. (No H. O.)	
Cawnpore ...	H. O. ...	M. E.	
Nagpur ...	H. O. ...	(Most katcha drains) M. E.	
Darjeeling ...	Both under	advise of C. S.	
Amritsar ...	H. O. ...	(Most katcha) M. E. except city main drain.	
Calcutta ...	M. E. ...	M. E. ...	Recently a discussion at the Corporation showed the existing system of Conservancy was thought unsatisfactory and there is a scheme on foot for future consideration that all Conservancy to be under Medical Men forming a special Conservancy Staff.

Place.	Roads and drains and latrines.	Storm water drains.	Remarks.
Colombo ...	M. E. ...	M. E.	
Bareilly ...	H. O. ...	M. E.	
Ootacamund ...	Partly M. E. ...	H. O.	
Madras ...	H. O. ...	H. O.	
Poona ...	H. O. ...	H. O. then M. E.	(Now regarded as unsatisfactory under M. E.)
Madura ...	H. O. ...	H. O.	
Rangoon ...	M. E. ...	M. F.	
Benares ...	H. O. ...	H. O.	
Agra ...	H. O. ...	H. O.	
Lahore ...	H. O. ...	Partly H. O. and M. E. (large ones under M. E.)	

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

INFANTILE MORTALITY, ITS CAUSE AND ITS PREVENTION.

BY

Rai Kailas Chandra Bose Bahadur, C.I.E., L.M.S.

The very heavy rate of mortality amongst infants born of Indian parents naturally calls for an explanation as to the probable causes of this fearful wastage of our national strength. From the records of thirty years which I have been able to collect through the kindness of the Chairman of the Calcutta Corporation and which I have embodied in my paper, you will find that out of the total number of births annually registered in Calcutta over 37 per cent infants died before they attained the age of twelve months, and out of the remaining 63 per cent 14 per cent died before they had lived for five years, showing thereby that the ratio of our increased wealth and prosperity is inverse to that of our national growth. It could never have been the intention of the Creator that these little folk should come into the world like so many winter season flowers to bloom for a day, week or month and then wither and drop to the ground on the advent of summer. They were surely sent here to fulfil some special purpose. The united efforts of the sanitarians and the patriots have hitherto failed to alter the situation and the death-rates amongst our infants continue high as ever. To avoid encroachment upon the time of the Conference, I would strictly confine my remarks to infant mortality as it occurs in Calcutta and its suburbs. Calcutta which only up to the last year was the metropolis of British India is at present inhabited by various sects of people most of whom have migrated from other parts of the world to settle themselves here for the benefit of their trade and commerce, and for business generally. The standard of health of one class differs from the standard of health of another class of people. The management of the lying-in-room and the method of the infant rearing of these different classes of citizens are not uniform in their character. It should be my humble endeavour to trace how far their social customs, rites and imprudent management influence the health and well-being of their infants. I would consider the case of the Hindus first, for they form the bulk of the inhabitants of the city. The poorer classes of Hindus for want of means and proper accommodation are always destined to give unsatisfactory returns of their lying-in-room and the loss of life amongst them is always very great. The middle and the respectable classes of Hindus are divided into three principal communities or sects—the Bengalis, the Marwaris and the Bombay 'banias'. The majority of the Bengalis belong to the salaried class of citizens who live in the congested and insanitary portion of the town to the detriment of their health which is their only capital. For obvious reasons they cannot possibly hope to get a better record of longevity. The educated portion of their community by their frequent association with their European brethren have learnt to do away with all sorts of idle prejudices and superstition which generally lead to the contamination of the atmosphere of a Hindu family and often prove a source of much needless annoyance and discomfort. The Marwaris who are blessed with a convenient share of prosperity, who are charitably disposed towards the poor, whose motto of religion is preservation of life, are, to their shame be it said, very much backward in matters of health, and it would be no exaggeration to say that nearly 50 per cent of their ladies die in the lying-in room and nearly 70 per cent of their infants die before they cut their teeth. A happy change, however, has taken place in the constitution of the society and they have now commenced to appreciate personal hygiene and it is hoped they would before long learn to value domestic hygiene which is at present shamefully neglected. Their ladies attribute every unfortunate incident in the confinement room to the influence of evil spirits and they say that infant death is inevitable and no human power can avert it.

From the description of their lying-in-room you will at once find that they of their own accord create factors of diseases and death and their imprudent actions at times become culpable. With a little digression from the main subject, I would try to give you an outline of a model of a lying-in-room with its equipment to enable the Conference to form an idea of the magnitude of the evil they foolishly court to satisfy the whims and fancies of their elderly ladies who are supposed to understand the management of labour cases better than their medical advisers and qualified midwives.

There is no special site for the selection of a lying-in-room. In a moderately rich house the worst, the most ill-ventilated room, better if it stands near to a privy, is reserved to serve the purpose of a confinement room during emergency. Before the parturient woman is taken into it, the elderly ladies of the house carefully examine whether all its openings have been well covered with canvas purdahs to prevent the access of air, which kind God has given free of all charges to all creatures under the sun. After having satisfied on all points they allow the expected mother to occupy her bed in the room. The room, in total disregard of its dimension, is unequally divided into two compartments by a screen made of old torn sacks impregnated with dust and germs of diverse kinds; the smaller compartment is reserved for the mother and the child and the bigger one for the accommodation of the matrons and the maids of the house. A low and filthy class of woman, vulgarly called "chamarnis" are engaged to discharge the function of midwives who are thought capable of doing everything necessary for the occasion and they are entrusted with the toilet of the child. You would, I doubt not, be disagreeably surprised to learn that the special function of the officious ladies of the house is to see that the mother does not fall asleep and they obstinately deny her this comfort for full 5 days. They consider sleep during the early period of confinement to be an evil which brings diseases and death to the mother. This practice has now been to a certain extent modified and the poor mother is allowed to sleep for a couple of hours during early morning. The mother after her delivery is laid on a charpoy with an old blanket to serve the purpose of a mattress and well covered with a quilt. All nourishment is denied to her and for 5 days she is to live upon a stuff made up of molasses, gum acacia and ajawan. We now turn to consider the fate of the child. If the child is exhausted and does not cry after his birth, it is left aside and taken for still born. If it cries the 'daie' divides the cord with split bamboo or with an old rusty knife as cricumstances would allow and then ties it up with thread. The bleeding, if any, is stopped by putting a piece of cotton wool over the wound. The child is then hurriedly wiped with a piece of soft linen soaked in mustard oil and the 'vernix caseosa' is thus partially removed. The toilet of the baby is finished; it is then well covered up with old rags selected from the refuse of clothes used by its ancestors. The ancestral old rag is considered to be an emblem of longevity. The face of the child is also well covered with clothes and it is very nearly smothered; the poor little thing is allowed to breathe its own respired air which he gets from what is confined within the various layers of his ragged garments. A 'chirag' is kept burning day and night and live charcoal is also kept within the room to keep it warm. The fire and the lamp consume the greater portion of the oxygen of the room. Carbonic acid gas poisoning is not a rare accident of the lying in-room of the Marwaries and Banias. I remember an instance where 13 women had to be dragged from the jaws of death and at this time whoever entered the room to rescue the inmates felt giddy and fell down unconscious and the whole thing was attributted to the doing of an evil spirit. The verandah of the room which forms its appendage is not void of its decoration; it is equally protected against the wind and forms the resting place of the confidential servants of the house who stay there during the night. They are well supplied with their usual ration of Ganja and Bhang which they enjoy to their heart's content. Their duty is to keep the inmates of the room awake and they do this by firing Chinese crackers almost every five minutes. Their deafening sounds often prevent neighbours from enjoying rest during the night. I have a drawing of the lying-in-room and you can well imagine the amount of evil it does to the health of the mother and the child. One would be agreeably surprised to find a mother and her child come out safe after their period of confinement which generally extends

to 40 days. The Bombay 'banias' seldom use crackers nor do they keep the mother awake. The vagaries of these two classes of people do not cease with the conversion of the confinement room into a black hole. They also unconsciously and foolishly poison the infant by putting opium into its mouth as soon as it is ushered into the world. In rare instances the practice of giving opium to an infant as its daily ration is delayed till it attains the age of 40 days. Cases of opium poisoning often fall into the lot of medical practitioners who practise amongst these people. Amongst the well-to-do class of Mahomedans the lying-in-room is often kept closed, but not absolutely air-tight. They also put live charcoal into the room. The toilet of the infant requires special attention to enable the members of the Conference to understand how far it is prejudicial to the interests of health. The 'mamens' and the 'socrties' who belong to the high class Bombay Mahomedan domiciled in Calcutta whose number is pretty large, bind their infants with several pieces of clothes to prevent free movement of the limbs. They take four square pieces of cloth each measuring 18 inches of the size and shape of a pocket handkerchief, folded from corner to corner to form into a triangle with its base upwards and tied round the infant in the following order, the first piece tied tight round the chest and upper arms of the infant, the second round the abdomen and the upper half of the forearms; the third tied round the waist and forearms and the fourth round the thighs and knees. The legs and feet are covered with a sufficiently broad piece of cloth but not likely tied up. All the knots are placed in front and they project upwards. In lifting up the child the mother or the nurse puts one hand under its neck and with the other holds one of the knots. I would now pass on to consider about infant feeding and its effects upon the health of the child. It is a popular belief that the child cries when it feels hungry and stops when it is put to the breast. Over-feeding and under-feeding are considered as relative terms having no intrinsic value of their own in the rearing of infants, and diseases and discomforts arising from these sources are often ignored. The majority of our people do not understand how the quality and quantity of a mother's milk is affected by the condition of her mind and body. A mother living under so many sanitary disadvantages cannot reasonably expect her child to be strong and healthy.

Amongst numerous other diseases which infants are liable to, tetanus and convulsions deserve special mention. The one comes before the child has completed the first fortnight of its life, the other often after it. Both are preventable diseases and with a little care or attention they could be made things of the past, but the task of doing it is a problem which I fear will long remain unsolved. Cleanliness is next to godliness; but cleanliness of person is greatly at discount in the Indian lying-in-room. With the exception of a limited number of the educated and enlightened class of people, the use of soap during ablution of the child is almost unknown. Two baths are generally given to the child during the whole period of its confinement to the maternity room, and baths according to the idea of the elderly ladies means sprinkling of tepid water over the head and body of the child. Head to foot bath is seldom given to the mother and the child. Purity of milk and the good hygienic conditions of the house and its environments increase the resisting power of the infant against diseases. The better condition of health of children whose parents live in European style demonstrates the truth of the maxim that infants however richly fed if deprived of the benefit of good air, do not thrive well. The 'bustees' of Calcutta where the average standard of health of infants is poor, invariably give better returns when they are reclaimed and the surroundings of huts improved by the opening out of the streets and introduction of better conservancy. From the list of diseases which beset the infant's life, you would find that the majority of them are caused by carelessness, by improper food, insufficient clothing and the bad hygienic condition under which the people live. Instances are known where better results have been obtained by change of residence from a congested to a healthier portion of the town. Figures speak better than mere statement of facts, and I would with your permission enumerate the diseases according to the rate of deaths they caused to the infants and would try to discuss the propriety of reducing their number by the introduction of sanitary reforms. From the mortuary returns of Calcutta for the last five years you would find that out of the total number of

registered deaths, bronchitis heads the list; then comes tetanus and convulsions, the third place is taken by intestinal disorder; then comes rickets and scurvy, then infantile liver. Malaria comes last.

Diseases brought on by neglect or carelessness.—I have already mentioned that tetanus which carries off a large number of our infants can be easily put out of business by paying a little attention to aseptic precautions in dividing the cord and handling it. In their attempt to introduce hygiene into the lying-in-room of the uneducated Indians, medical men have often been accused of selfishness and unnecessary interference by the people whose interest they so eagerly seek to promote. It is simply gratifying to mention that in some quarters the ladies themselves have been able to do away with their superstition and idle fear and have introduced reforms into their houses, but their number to our regret be it said is simply microscopic.

Insufficient clothing as a factor of disease.—The majority of the ragged Indians from want of means cannot and do not use any clothing to protect their infants against chill and cold, and the extent of their misery could be better imagined than described. The working class of people like the Spartans freely expose their darlings to the wind and sun under the impression of making them hard and thus increasing their wage-earning capacity when they grow old. They absolutely avoid using garments for their children. The middle class men dress their children with socks, coats and woollen caps during the afternoon simply with the object of attracting attention of the inmates of the house and their neighbours, and on the approach of the evening they abruptly take off the garments and put them to their beds. The rich and the fashionable class of people of the city use fine muslins and pine apple coats with lace border and expose their infants to the influence of cold and chill and thus render the system susceptible to diseases of the respiratory tract. Bronchitis and pneumonia often arise from this source and play havoc amongst infants of tender age. In spite of all remonstrances the imprudent Indian mothers will stick to their folly and keep themselves content by saying that they should do for their children all that their old mothers did for them. Improper and injudicious feeding of infants is a fruitful cause of infantile diarrhœa, and unless we can teach your young mothers the art of feeding, we must always expect to have such unsatisfactory return of our infantile deaths Amongst the Marwaris and Banias there is an irresistible desire to give solid food to their infants at as early an age as four months and the food consists of mashed potatoes, boiled rice and dal (kchichoory) and 'halooa' or porridge made of starch, sooji, ghee, or clarified butter and sugar and 'chapaties' or hand-made bread, and curd. You can at once imagine the amount of mischief they do to the delicate stomachs of their darlings. The indiscretion of the young mother causes gripes and convulsions which often trouble their little folks until acute diarrhœa, dysentery and intestinal catarrh, infantile liver, supervene either to put an end to their sufferings and carry them off or to make them live to die of slow starvation. Rickets is a favourite offspring of malnutrition and is frequently found amongst the Indian infants. Although its existence has been denied by some eminent authorities, the symptoms of true rickets manifest themselves from the early age of nine months. It is a disease which undermines the health of the infant to a deplorable extent and although it does not kill it at once it reduces the resisting power of the system and renders it susceptible to diverse disorders. It would not be out of place to mention that owing to the scanty milk supply of the town and the dearness of its price, people largely use tinned milk whose consumption in the Calcutta market is very great. Scurvy, a disease hitherto unknown, has of late been added to the list of infantile diseases, and although in the mortuary return we do not often get its name, nevertheless it is occasionally found amongst the Indian infants after they have passed the period of dentition.

Voluntary exposing children to the infection of contagious diseases.—There are still classes of people who court small-pox and measles by voluntarily exposing their children to their infection. It would stagger humanity to learn that in the district of Burra Bazar where a group of families live in one house, people do not have recourse to vaccination. When small-pox breaks out amongst them they allow their children to mix freely with their sick friends.

The mothers carry their infants on their arms in paying their friendly visit to a neighbour's child laid up with small-pox or measles. They intentionally carry the germ of the diseases to their respective homes and take pride in doing it. They still believe that separation of the sick from the healthy children means incurring displeasure of the goddess of small-pox, who in her wrath might specially select a malignant form of the disease for their children. Infants are destined to pay the penalty for the ignorance of their parents.

There is a class of irresponsible persons who hold dentition as the causative factor of many infantile disorders, especially those that come after the child has attained the age of nine months. They resolutely deprive him of the benefit of medical treatment and allow him to suffer or die according to the gravity or otherwise of their disease. I have often tried but failed to bring them to their senses by assuring them that the dentition itself does not cause convulsions, diarrhœa, or any other serious distemper. It is a physiological process which when interfered with seriously tells upon the resisting power of the infants against diseases. The District of Burra Bazar which includes Wards Nos. 5 and 7, gives extremely unsatisfactory returns of its vital statistics. The Health Officer of Calcutta has very kindly supplied me with a record of such statistics for the last five years, and on comparing it with the results of other districts you will find that infant mortality is running high amongst people living in Wards Nos. 5 and 7; and most of the deaths are due to the ignorance of the people.

Ward No. V.

——	1907.	1908.	1909.	1910.	1911.
Births	725	725	810	663	756
Deaths	432	450	462	448	436
Balance ...	293	275	348	215	320

Ward No. VII.

Births	318	385	810	307	345
Deaths	197	169	215	155	166
Balance ...	121	216	595	152	179

I think and I believe that I have been able to establish the fact that superstition, indiscretion and ignorance of the people are the direct factors of most of the diseases which Indian infants are liable to and the remedy lies not in making rigid laws to guide mothers in rearing up their infants but in making education compulsory. It is only by education we can drive away their superstitious feeling and vague ideas. It is necessary that books on hygiene should be taught in coloquial vernacular and it should hold a separate chapter on rearing up of infants and prevention of their disease. The book should be approved by the board of study and introduced into schools intended for the education of girls. There are pamphlets and dialogues which do not hold all that is wanted; besides they are not understood by the ignorant classes of people. The Government should be approached to take up the matter for its kind consideration and be respectfully requested to organise a separate department for the diffusion of knowledge of sanitary science through the medium of peripatetic lady sanitary inspectors whose functions shall be to preach the doctrines of hygiene with special

relation to the advantages of good air ; good water ; cleanliness of dress ; purity of food ; the disadvantages of artificial feeding of the infants ; the necessity of early vaccination and the value of isolation of contagious diseases to the uneducated class of people who do not educate their ladies. That early marriage as far as practicable should be prevented and that marriage amongst the weak and infirm should be discouraged. That only those who have received special training in the management of the normal labour cases and in the toilet of infants should be allowed to discharge the function of " daies " and that the site of lying-in-room and its equipment should be sanctioned and approved by a qualified medical man. That it shall be a duty incumbent upon the owner of a house to notify to the authorities the occurrence of any contagious diseases in his family and the arrangement he has made for the isolation of the sick or for segregation and safety of the other members of his family. The Corporation of Calcutta has appointed four female sanitary inspectors or midwives to advise and help parturient women during emergency but their number is ridiculously small to cope with the burden of the work. It is essentially necessary that special arrangements should be made to increase the supply of pure milk and this we can not do better than by protecting prime cows as is done in the other parts of the world. It is a matter of regret that in Calcutta—which forms the centre of the agricultural district of Bengal there should be a constant famine of milk and that tinned milk should supply the wants of the majority of her people. If we ever succeed in carrying out these measures we may reasonably hope to reduce the death rates of infants to a material extent.

TABLE A.—*Deaths of Infants—1907.*

	Under one month.	Up to one year.	Total.	Percentage on infant deaths.	Total.
Small-pox	10	173	183	...	...
Measles	2	15	17	...	...
Fever	27	100	127	...	...
Malaria	5	19	24	351	7·3
Diarrhœa	24	92	116	...	...
Enteritis	24	92	116	...	...
Cholera	...	39	39	...	...
Dysentery	10	64	74	345	7·2
Premature birth	524	...	524	...	...
Debility at or from birth	683	7	690	...	...
Mrasumas, neglect, etc.	5	28	33	1,247	26·2
Bronchitis	334	953	1,287	...	...
Pneumonia	2	80	82	1,369	28·7
Tuberculosis (all forms)	4	3	7	7	·1
Tetanus and convulsions	955	73	1,028	1,028	21·6
Infantile Liver	49	179	228	228	4·7
Syphilis	4	12	16	16	·3
All other causes	97	66	163	163	3·4
Total ...	2,759	1,995	4,754	...	...

TABLE B.—*Deaths of Infants—1908.*

——	Under one month.	Up to one year.	Total.	Percentage on infant deaths.	Total.
Small-pox	2	49	51	...	...
Measles	1	47	48	...	...
Fever	9	54	63	...	...
Malaria	1	4	5	...	3·6
Diarrhœa	13	81	94	...	...
Enteritis	12	117	...	...	...
Cholera	3	54	57	...	...
Dysentery	3	76	79	...	7·8
Premature birth	433	4	437	...	...
Debility at or from birth	654	10	664	...	...
Marasums, neglect, etc.	4	13	17	...	24·3
Bronchitis	264	1,213	1,477	..	...
Pneumonia	1	112	113	...	34·6
Tuberculosis (all forms)	...	5	5	...	...
Tetanus and convulsions	740	83	823	...	...
Infantile Liver	6	237	243	...	...
Syphilis	3	22	25	...	...
All other causes	80	185	265	...	29·6
Total ...	2,229	2,366	4,595	...	...

TABLE C.—*Deaths of Infants—1909.*

—	Under one month.	Up to one year.	Total	Percentage on infant deaths.	Total.
Small-pox	27	489	516	...	...
Measles	1	25	26	...	...
Fever	17	74	91	...	...
Malaria	3	15	18	651	12·5
Diarrhœa	8	52	60	...	...
Enteritis	14	134	148	...	...
Cholera	1	50	51	...	...
Dysentery	4	39	43	302	5·8
Premature birth	492	3	495	...	...
Debility at birth	742	23	765	...	...
Marasums, neglect, etc.	7	15	22	1,282	24·6
Phthisis	1	2	3	...	...
Bronchitis	283	1,033	1,316	...	...
Pneumonia	9	136	145	1,464	28·1
Tetanus	932	36	968	...	...
Convulsions	43	93	136	1,104	21·2
Syphilis	7	12	19	...	...
Infantile Liver	4	186	190	...	...
All other causes	103	91	194	403	7·8
Total ...	2,698	2,508	5,206	...	...

TABLE D.—*Deaths of Infants—1910.*

—	Under one month.	Up to one year.	Total.	Percentage on infant deaths.	Total.
Small-pox	...	7	7	...	...
Measles	2	52	54	...	...
Fever	21	109	130	...	...
Malaria	...	9	9	200	4·3
Diarrhœa	7	47	54	...	...
Enteritis	15	132	147	...	...
Cholera	1	40	41	...	...
Dysentery	...	55	55	297	6·3
Premature birth	422	4	426	...	...
Debility at birth	793	7	800	...	...
Marasums, etc.	8	21	29	1,255	26·8
Phthisis	...	1	1	...	...
Bronchitis	265	117	1,382	...	...
Pneumonia	6	136	142	1,525	32·6
Tetanus, etc.	892	41	933	...	...
Convulsions	23	53	76	1,009	21·6
Syphilis	3	18	21	...	...
Infantile Liver	5	144	149	...	...
All other causes	113	110	223	393	8·4
Total ...	2,576	2,103	4,679	...	100·0

TABLE D (*a*)—*Proportion of deaths at age periods to rate of infant mortality.*

Under 7 days.	7 days to 1 month.	1 month to 2 months.	2 months to 3.
106·8	43·1	18·8	13·5

3 months to 6 months.	6 months to 12 months.	
30·3	59·8	Total ... 273

Table E.—*Deaths of Infants—1911.*

——	Under one month.	Up to one year.	Total.	Percentage on infant deaths	Total.
Small-pox	...	4	4	...	...
Measles	...	14	14	...	...
Fever	...	71	71	...	...
Malaria	...	3	3	92	1·9
Diarrhœa	...	60	60	...	...
Enteritis	...	137	137	...	...
Cholera	...	25	25	...	...
Dysentery	...	97	97	319	6·5
Premature birth	454	3	457	...	...
Debility at birth	831	12	843	...	...
Marasums etc.	19	16	35	1,335	27·1
Phthisis	...	3	3	...	...
Bronchitis	343	1,372	1,715	...	...
Pneumonia	3	124	127	1,845	37·6
Tetanus	846	97	943	...	...
Convulsions	47	50	97	1,040	21·6
Syphilis	2	25	27	...	...
Infantile Liver	9	156	165	...	...
All other causes	...	89	89	280	5·7
Total ...	2,550	2,361	4,911	...	100·00

Table E (*a*)—*Proportion of deaths at age periods to rate of infant mortality.*

Under 7 days.	7 days up to 1 month.	1 month to 2 months.	2 months to 3.
93·3	37·4	15·7	21·2

3 months to 6 months.	6 months to 12 months.	
32·2	51·2	Total 251

TABLE F.—*Deaths of infants.*

—	1907.	1908.	1909.
Infectious diseases	92·63	9·8	33·52
Diarrhœa	21·26	21·0	15·55
Convulsions and tetanus	63·36	48·2	56·48
Prematurity and debility	76·86	65·6	66·0
Pulmonary diseases	34·38	93·3	75·37
All other causes	25·53	31·53	31·3
Total ...	293·02	269·0	268·03

	1907 (England).
Infectious diseases	8·46
Diarrhœa	14·06
Convulsions and tetanus	11·06
Prematurity and debility	41·46
Pulmonary disease	23·26
All other causes	19·32
Total ...	117·62

It may be noted that the deaths of infants under 7 days of ages form 37 per cent. of total infant deaths.

TABLE G.—*Infantile mortality—Calcutta.*

Year.	Births.	Under 1 year.	Under 5 years.	Still born.	Total.	Census population.
1882	7,505	2,600	919	499	4,018	4,33,219
1883	7,655	2,376	993	534	3,903	Do.
1884	8,290	2,663	1,126	562	4,357	Do.
1885	8,358	2,819	1,322	501	4,642	Do.
1886	7,827	2,460	1,240	517	4,217	Do.
1887	7,954	2,426	1,050	566	4,042	Do.
1888	8,643	2,520	1,124	656	4,300	Do.
Amalgamated area ...	...	...	...	...	...	...
1889	12,317	2,743	1,128	597	4,468	6,82,305
1890	11,918	2,392	1,426	532	4,350	Do.
1891	12,477	2,450	1,325	580	4,355	Do.
1892	12,688	2,830	1,886	905	5,621	Do.
1893	13,492	4,070	1,831	964	6,865	Do.
1894	11,438	3,940	2,326	...	6,266	Do.
1895	10,945	5,094	2,776	...	7,870	Do
1896	12,608	4,265	2,012	...	6,277	Do.
1897	12,584	3,492	2,326	...	5,818	Do.
1898	9,530	3,610	1,858	...	5,468	Do.
1899	11,004	4,037	2,027	...	6,064	Do.
1900	10,773	4,877	3,242	...	8,119	Do.
1901	9,129	4,401	2,885	841	8,127	8,47,796
1902	12,122	4,483	2,412	916	7,811	Do.
1903	13,182	4,161	2,115	936	7,212	Do.
1904	15,250	4,538	2,106	992	7,636	Do.

TABLE G.—*Infantile mortality—Calcutta.*

1905	15,637	4,959	2,596	7,555	8,47,796
1906	15,083	5,141	3,505	8,646	8,47,796
1907	16,224	5,754	3,029	7,783	8,47,796
1908	17,043	4,595	2,147	6,742	8,47,796
1909	19,423	5,146	2,762	7,908	8,47,796
1910	17,106	4,679	2,322	7,001	8,47,796
1911	19,515	4,911	2,156	7,067	8,96,067

ALL-INDIA SANITARY CONFERENCE--MADRAS--NOVEMBER 1912.

THE OUTBREAK OF EPIDEMIC FEVER IN CALCUTTA.

BY

Rai Kailas Chandra Bose Bahadur, C.I.E., L.M.S.

Preamble.

The recent outbreak of epidemic fever in Calcutta has caused no little amount of excitement amongst the educated and uneducated classes of the people living in the northern section of the town. There never was so much divergence of opinion amongst professional men as was evinced during the present outbreak of fever. Various theories have been started as to the origin of this peculiar kind of fever which, unlike Plague or any other form of malignant disease, does not kill its victims outright, but makes them miserable and helpless for a week or ten days. The majority are invalided for about a month or two. Indeed there was no lack of suggestions threshed out in papers, but which we are least concerned with at the present moment. We are directly interested with the views of the medical men which alone can help us in understanding the nature of the disease. The Health Special Committee of the Calcutta Corporation had moved a resolution to the effect that Government might be asked to depute a specialist to investigate the circumstances of the outbreak and classify the distemper. One set of medical practitioners preferred to call it Calcutta fever, three-day fever or seven-day fever, according to their whims and fancies. Another batch of medical men believed that it was an exanthem which periodically breaks out in Calcutta, specially during the rains, and which for want of investigation has not yet been classified, whilst the bulk of the profession was of opinion that it was no other fever than Dengue of 1871. Whatever may be the views of medical men regarding the identity of the disease, it must be admitted that a correct diagnosis is essentially necessary without which all attempts to stamp it out or prevent its spread will, I fear, be futile. It shall be my humble endeavour to place before the Conference materials to enable the members to pick out points for their consideration and throw sufficient light on the subject which has given rise to so much controversy.

Medical opinions differ.

The theory of three-day or seven-day fever does not stand the test of time and I need not try your patience by discussing the point here. I only wonder how medical men, in the face of the exhaustive literature on the subject by Professor Rogers, could venture to hold this view.

Exanthema and Dengue.

The question of exanthem next comes for our consideration, and with regard to this point it may be said that since so far back as the year 1880 we have been seeing cases of a peculiar kind of eruptive fever in which the rash appears on the second or the third day of the fever and lasts longer than one week. In rare instances the rash does not appear till the seventh or eighth day. The disease is highly contagious in its character. Dr. K. McLeod, Professor of Surgery in the Medical College and the then Health Officer of Calcutta, was the first to draw the attention of practitioners to the existence of the disease in Calcutta. He read an interesting paper on the subject before the Calcutta Medical Society which was published in the Indian Medical Gazette as well as in the transactions of the Society. The opinions of medical men were divided—some called it scarlatina, others named it German measles, and a selected few, amongst whom Dr. D. B. Smith, the then Principal of the Calcutta Medical College, occupied a prominent place, styled it as Dengue. I would with your permission read an extract from the proceedings of the Institution where the subject was read and discussed.

"During the past hot weather and rains I have met with several cases of an eruptive fever which presented varying and anomalous phases. In one case, which I am inclined to consider typical, a boy of about five years of age was suddenly seized with high fever. He had just recovered from an attack of acute tonsilitis. The pyrexia was very intense and prostrating. Next day a bright rash appeared on his body and extremities. The patches, originally small and circular, coalesced and became irregular and somewhat diffused. They were slightly, if at all, raised above the surface. The fever subsided on the appearance of this efflorescence. The rash itself faded away in a day or two, and three or four days from the onset of the disease the boy was quite well. No desquamation or dropsy ensued, and there was neither coryza or bronchial catarrh. His sister got an attack of tonsilitis with fever a few days afterwards, but she had no rash. In another family three children were attacked, but their symptoms presented a good deal of variation. The first case was a baby boy, 7 months old. He got high fever suddenly with bronchitis, some tonsilitis and extreme restlessness. The temperature reached 105 degrees in the earlier days of the disease. The symptoms did not present much change for a week. The incisors were tense and prominent, and I lanced the gum over them freely. This afforded relief. The fever and bronchitis subsided gradually during the next week and a roseolar rash in large patches appeared on body and extremities for a few days during its subsidence. No disquamation or anasarca supervened.

Extract from the proceedings of the Calcutta Medical Society.

A little sister about two years old got during the baby's convalescence an attack of fever, bronchial catarrh and tonsilitis. The same kind of eruption appeared on the second or the third day and faded in a day or two. A brother, about 4 years old, got feverish about the same time and showed the same rash on the second day. He recovered in 4 or 5 days.

In another family an infant was attacked exactly in the same way as the baby whose case I described; the fever, bronchitis and restlessness being very prominent. On appearance of the rash on the fourth day the symptoms subsided and recovery took place in about a week. In another case a little girl of three years got out of sorts, lost her appetite and spirits, and got a furred tongue and constipation. I was treating her with rhubarb and magnesia when roseolar patches appeared on the body, lasting for a day or two, and with their disappearance health was restored. Another little girl presented precisely similar symptoms; but after recovery had taken place from the eruptive malady, she got a diphtheritic sore-throat which almost killed her.

In an adult, a married lady, high fever set in with a general flush of face and body and severe pains in the back bones. The suffusion lasted for a day or two and the pyrexia and its concomitant discomforts disappeared in about a week.

Those cases are very vaguely described from memory, but occurring as they did at short intervals, and without any communication with each other, it appeared to me desirable to appeal to the experience of other practitioners and I accordingly in my capacity of Health Officer addressed to every medical man practising in Calcutta a circular with a view to elicit information on the subject of this anomalous exanthem. I have been favoured with 19 replies, and though I have reason to believe that more will be forthcoming, those which I have already received contain matter of sufficient interest and detail to stimulate observation and discussion.

Thirteen of the nineteen had met with cases of fever with eruption and six had not seen any. Some of the reporters had treated many cases—one 50, one 20, but most had encountered a few—from 6 to dozen. Infants and children were the usual victims, but a few adult cases are described. Only one had seen the disease prove fatal in three cases out of fifty.

Analysis shows the disconnection of exanthema with the epidemic fever.

The cases were observed mostly during the months of June, July and August. Opinions vary regarding the type of the disease, some looking upon it as a mild scarlatina, others as a rubeola or rotheln and others as a mitigated dengue."

On carefully analysing the symptoms we do not easily find our way to link it with the form now prevalent in Calcutta.

The Conference is next called upon to decide whether the fever which now prevails in Calcutta and the description of which they might have read in medical journals, is dengue, and if so does it strictly follow the same course as it did during the epidemics of 1780, 1824, 1853 and 1871. Whether diseases are capable of changing their type during various epidemics? We have often seen variation in intensity during epidemics, but we have never seen change in the character and phases of the disease itself. Consideration of these points by the Conference will, I doubt not, be very much appreciated by the medical public who are anxiously watching its verdict. To minimise labour and reduce the bulk of the paper, I would only venture to place before the Conference a few salient points where the disease has been found to deviate from its usual course and present phases which were not noticed during its previous outbreaks. It may be mentioned that the description of the character, course and symptoms of Dengue as given by Sir Patric Manson and Professor Charles, does not exactly correspond with the phases of the disease as was observed during the present epidemic, and hence arises our difficulty in diagnosing it. It is a matter of regret that no mention of Dengue can be had in ancient record of the Hindu system of medicine, and our intimate knowledge about it dates from the year 1871. We are therefore justified in arguing the subject only on the strength of facts observed during the epidemic of that year. From the year 1871-72 Calcutta has never been entirely free from Dengue; reports of isolated cases can be had from medical men of established reputation. Brigade-Surgeon Edward A. Birch treated several cases in the Presidency General Hospital during the year 1880. Colonel Harris remembers seeing one typical case of Dengue in the General Hospital in the same year. In the year 1903 it broke out in an epidemic form in the district of Burra Bazar, and I remember an instance when in one day I was able to show 56 cases of Dengue to the Health Officer of Calcutta. It was quite peculiar that the outbreak was confined within an area of a quarter of mile. The symptoms were unmistakable and they were absolutely like those observed during the previous epidemic. On or about the 15th April last when plague was on its wane, when people were about to shake off their nervousness and pay better attention to their business, a report of the advent of a peculiar kind of fever in their midst upset them all for the time being. I remember an instance where a young friend of mine came to me with an anxious look and reported that three members of his family, including his wife, were down with plague; they were simultaneously taken ill and he demanded my immediate presence. On examination the cases proved other than plague, and to the agreeable surprise of their friends the patients got up the next day. During fever they had intense headache, redness of the eyes and pain over the body. One of them had a red flush over his person, whilst others escaped without it. The menial establishment of the house was next taken ill. Fortunately, however, the disease was confined to a small area of the northern division of the town, and there was not much agitation about it. But circumstances soon altered and the distemper rapidly spread into diverse directions of the town and its suburbs. The epidemic fever formed the subject of conversation amongst people of all ranks and stations in life. How the medical profession took it has already been stated. It is not my intention to trouble you by discussing the symptoms of the disease. I would only mention the points where the anomaly exists and which tends to distinguish the present from the past epidemic of Dengue, and which is my only apology for bringing up the subject before you. In the absence of any other tropical disease resembling Dengue in its character and course, it would, I fear, be unwise to attempt to call the present epidemic fever by a different name. Whenever Dengue visited Calcutta we had the history of its migration from other centres of the world where it was prevalent as an epidemic, but we have no such report to account for the present outbreak. There is a class of practitioners who emphatically hold that under favourable circumstances sporadic cases might assume an epidemic form, and they attribute the origin of the present epidemic to this

Calcutta was never free from Dengue since 1871.

Symptoms noticed at the beginning.

Dengue migrates from other places.

source. It is gratifying to note that the intensity of the present epidemic was much less than what it was during the year 1871. Nearly 60 per cent of the residents of Calcutta were not affected by the disease, whilst during the last epidemic more than 70 per cent of her people was down with it. The fever did not spare age, sex and rank in its victims; its influence was even manifested amongst domestic animals. Amongst numerous other peculiarities noticed during the present outbreak of fever, the first and foremost was the uncertainty of its period of incubation. In a family of 36 members, 19 fell victims to Dengue and they all had it from within a few hours to six weeks after their exposure to its influence. In another family consisting of 20 members, three only suffered from the disease and they were all laid up simultaneously; the remaining 17 who mixed freely with the sick escaped untouched by the distemper. A respectable Mahomedan lady who attended upon her sick children during the last week of August, contracted the disease in the beginning of October. This was really a departure from the usual course of an eruptive fever. Such anomaly never existed before, and the period of incubation in Dengue often ranged from 3 to 6 days. In the usual course of Dengue, fever practitioners have always marked three distinct stages, the stage of invasion, the stage of remission and the stage of relapse. This arrangement was, however, greatly disturbed during the recent epidemic; no two cases presented uniformity of character. In the majority of instances, the third stage was absolutely wanting, and the patient recovered, and recovered for good, within 36 hours from the time of its invasion; in some the course of each of the three stages was completed within 3 days. The next point of interest was the absence of the characteristic rash. Dr. Goodive in describing the epidemic of 1853, styled it as red fever and his statement was verified during the epidemic of 1871. It would not be out of place to mention that Dr. S. G. Chuckerbutty, Professor of Clinical Medicine, Medical College, whilst demonstrating a case of Dengue to his students remarked that unlike scarlatina and measles, the redness in Dengue is so well marked and so uniformly distributed over the body, that one would be easily led to believe that the patient before he was taken to bed was playing "holi". It happened so that the epidemic of 1871 broke out during the time of the "Holi" festival in which, according to the custom of the people, they throw red powder over each other's bodies. The recent epidemic of fever was conspicuous by the absence of any such flush. The majority were without it. There were cases where the primary or secondary rash was wanting at the begining, but after a lapse of three weeks the patients had eruptions over the body; the palms of the hands and soles of the feet were also covered with a coppery rash which lasted for a couple of days and then subsided by desquamation. The pain in most of the cases was of a fugitive nature. It is a common complication of eruptive fever that the cervical, the axilliary and the inguinals glands swell and become painful to the touch, but they rarely suppurate. Dengue is not an exception to the rule. Instances of acute inflammation of the lymphatic glands and their subsequent suppuration were not infrequent during the present outbreak of fever. Multiple abscesses as a sequel to the epidemic fever were seen in some cases and there were authentic reports of suppuration of joints resembling very much the pyaemic abscesses of the pre-aseptic age. To none amongst the peculiarities observed during the recent outbreak is more attention due than to the presence of the complication just mentioned. By whatever name we may call the disease, there is not the slightest shadow of a doubt that vigorous search for its causative factors is imperative, and which alone can restore peace and harmony in the minds of the people who are very much disappointed at the present moment. Scarcely two years had elapsed and long before the poor labouring classes of Calcutta and its suburbs could regain their strength and wage-earning capacity, which they had lost during the ravages of epidemic dropsy, the outbreak of another epidemic in the form of Dengue amongst them could only be counted as a factor of their further misery and troubles. The present outbreak of epidemic disease in Calcutta deserves close and

Indefinite period of its incubation

Deviation from its usual course.

Suppuration of joints as sequel to the epidemic fever.

Co-operation of Medical Practitioners with the Sanitary authorities necessary.

thorough investigation by the Sanitary authorities, but to achieve success, the hearty co-operation of all who are interested in the health and well-being of the town is absolutely necessary. I think and I believe that we are morally responsible to Government and to the people to do it. The age does not permit us to say that we must always be prepared to meet with such mishaps and attribute the outbreak of epidemic diseases to the Will of God or to the doing of an evil spirit. We are bound to trace the source and it would be a menace to progress if we do not do it. A man who is dead ceases to be a subject of Government, he is no longer a useful member of his family, he can do no good to his people. The health officer is no longer responsible for him; his body must be cremated or buried before it is allowed to decompose and become a factor of disease. It is for the benefit of those who survive him, that the duties of the health officer or the Sanitary Commissioner are legitimately concerned. He must advise people how best to ward off a contagious disease; he must also tell them what precautions they should take to make epidemic disease a thing of the past The theory of the spread of the epidemic fever through the agency of 'Culex Fatigans' as stated by the health officer should be received with caution. This particular variety of mosquito is not easily found in Calcutta and their access into the Grand Hotel, into the houses of the Judges of the High Court and other palatial buildings is not very easy. Besides the inmates of such respectable houses sleep under curtains. We must therefore search for the source from other factors. At present we are absolutely in the dark as regards the causative factors of the new distemper. We do not know under what peculiar condition of the soil and atmosphere these ultra-microscopic germs develop or their recrudescence takes place and through what channel they enter the system. With our present knowledge of the disease we can simply judge the intensity of the toxine by the gravity of the symptoms it produces and the time it takes in eliminating the poison from the system.

The theory of the spread of the disease through the medium of Culex Fatigans.

Another fact which may not be lost sight of is the rapidity with which the disease died out in 1880 and 1903. The filthy habit of people to collect débris and refuse in the courtyard of their houses may be counted as a factor of dissemination of the epidemic fever amongst their inmates. It is a matter very much to be regretted that in the present arrangement of things people cannot expect to have any warning from the sanitary authorities against the inroads of diseases which when they break out in epidemic form fearfully undermine their health and lower their resisting powers. In spite of the many sanitary reforms lately introduced into Calcutta, and in spite of the numerous other hopeful expectations of improvement in the near furture, the standard of health of its people has not undergone any change for the better and the death rate of the town still exceeds its birth-rate. The time has come when something radical ought to be done to prevent the recurrence of outbreaks of epidemic diseases. Oft repeated attacks of epidemic distempers fearfully exhaust the resources of a town or city and entail heavy loss on the State. As the subject of my paper is simply to ascertain whether the present epidemic fever of Calcutta is Dengue in its usual form or has it changed its type, and whether such change has been frequently noticed, I need not go beyond the tract. I fear in my attempt to remove anomaly in diagnosing the disease and tracing its causative factors, I am myself running the risk of introducing anomaly in my paper.

Conclusion.

PART VI.

SEWAGE AND REFUSE DISPOSAL.

475DE

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

PRELIMINARY PAPER ON THE POONA EXPERIMENTAL SEWAGE INSTALLATION

By

MAJOR F. H. G. HUTCHINSON, M.B., C.M., D.P.H., I.M.S., OFFICER ON SPECIAL DUTY, EXPERIMENTAL SEWAGE INSTALLATION, POONA.

Object of the installation.—The Royal Commissioners on sewage disposal in their 5th report observe that "very strong sewages * * contain more suspended and colloidal matter than weak sewage," *** "the actual proportion of colloidal to suspended matter in sewage is not great; but since the amount of colloidal matter is frequently rather larger in a septic tank liquor than in its corresponding sewage, the proportion of colloidal to suspended matter in a strong septic tank liquor may be considerable. Such a liquor would exercise a greater clogging effect on a filter of fine or medium-sized material than its figure for suspended solids would lead one to expect. Moreover the septic liquor and sludge produced from such a sewage would almost certainly give rise to considerable smell ***". The Commissioners further remark that "it is by no means to be thought that finality has been reached in the preliminary treatment of sewage. New combinations of tanks or of processes may lead to much improvement."

These extracts define the scope of the experiments: it is necessary to add that the installation is not intended to throw any light on the relative merits of the preliminary treatment of sewage in septic, sedimentation and chemical precipitation tanks; for the degree of supervision requisite for the efficient management of sedimentation and precipitation tanks will generally not be forthcoming for small installations on this side of India.

Description of installation.—The installation comprises the following:—4 mixing chambers for sewage, 4 septic tanks, sets of "hydrolytic" and "macerating" tanks, 4 streaming filters. The effluents from the streaming filters pass direct in to a *nulla*.

The mixing chambers are rectangular tanks, each with a capacity of 200 gallons; the floors are sunk 3 inches below the level of the invert of the outlets which are controlled by 6 inches screw-down sluice valves.

Septic tanks.—All tanks are rectangular, the total water containing capacity is 2,300 gallons; the floors slope from the outlet to inlet, and in 2 of the tanks are sunk at the inlet end so as to form a chamber 2′ by 2′ by 1′ deep. The ratio of length to breadth is as 1:4 and as 1:5. Scum-boards with 2′ effective depth are placed 3″ from inlet and outlet ends. Near the inlet end of each tank is placed a baffle wall in the lower half of which are pigeon holes. It is possible to vary the capacity of the inlet chamber by altering the position of the baffle wall. The mean depth of each tank is 5′; the intake of sewage is by means of a 6″ pipe opening 2′6″ below water level. All the tanks are uncovered. The effluent from each tank passes over a weir opening into a channel leading direct to the streaming filters, or can be diverted at will through one or other of the secondary tanks.

Hydrolytic tanks.—These tanks are chambers in which sloping wooden boards are suspended. The intake for sewage or septic tank effluent is from below.

Macerating tanks.—In these tanks is a false bottom of perforated iron sheeting on which rests broken brick or stone. The inlet is below the false bottom.

Streaming filters.—The filters are constructed with solid masonry walls, and have an effective depth of about 8′. Half 6″ pipes of galvanised iron run across the filters at varying depths to permit of effluent samples being drawn off at these points. Distribution is by means of galvanised gutters perforated along the sides and floor.

Sewage.—The sewage is of a purely domestic character, and is made artificially from the excrement taken from two public latrines—one for either sex. The inhabitants of the houses in the neighbourhood of the latrines follow home industries, so it is probable that all alvine discharges, with the exception of those passed in the dark, are found in the latrines; this is especially true for the female community. Each latrine has 6 seats; there is a stone floor, not absolutely impervious owing to faulty joints, sloping towards a central gutter which leads to a cesspool: iron pans catch the solid matter and some of the urine and ablution water, but the majority of the latter finds its way direct to the cesspool Over each latrine is a recording turnstile. The water for mixing with the excrement, so as to form a sewage of the required dilution, is pumped from a well on the banks of a *nulla*, which acts as a sewer for the city.

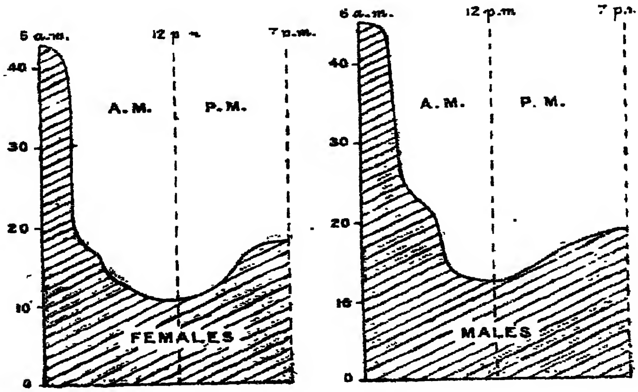
Working of the installation.—The numbers using the latrines are recorded at regular intervals between 6 A M. and some hour between 6 and 10 P.M. From these figures it is possible to calculate what would be approximately the hourly variation in sewers under normal conditions, and to regulate the valves commanding the outlets of the mixing chambers to feed the septic tanks accordingly. The total excrement, solid and liquid, is measured by volume, and the average output per *user* calculated Volume per user must be distinguished from volume per head of population: on this side of India the individual defecates more than once daily, the average number of visits has been found to be 1·6 for both men and women. Volume per user × 1 6 is equivalent therefore to volume per head of population: with this figure it is simple to manufacture a sewage of any required dilution; the method is sufficiently accurate for the purposes of the experiment, for fallacies are minimised by the numbers using the latrines. Over 600 visits are paid daily, which works out to an average of between 50 and 60 per seat. Allowing 1·6 visits per individual each seat has to accommodate daily over 30 persons.

Volume of excrement per individual..—An attempt was made to estimate the average volume of ablution water used, but was abandoned owing to the impossibility of obtaining reliable figures; some bring no vessels and use just the damp hand, while the capacity of the vessels brought by others varies from 2 to 3 ounces up to half a pint and over. Some refill their vessels at the tap so as to wash their feet and hands.

For each woman entering the latrines 0·169 gallon of excrement (solid and liquid) was collected, of this 0 097 gallon was in the iron pans. This represents an average for 7 months work. For men the average only differs in the third place of decimals, but the proportion collected in the pans is higher. Multiplying again by 1 6 the volume of excrement per individual comes to 0 2704 gallons for women, and 0·2656 gallons for men. These figures do not include the water used in washing latrines. One gallon of sewage, therefore, represents the output of 3·69 adults. On considering that some of the urine is passed outside the latrine, the difference from Captain Gourlay's estimate in Dacca—1 gallon to represent the output of 3·308 adults—is not great. Taking the pans alone 1 gallon is equivalent to the yield of 7·02 adults, but this figure cannot be used as a basis for calculating the volume of sewage to be removed when the people do not use ablution water.

Daily variation in the use of the latrines.—The daily variation is shown best by means of the curves, which represent the use of the latrines between 6 A.M. and 7 P.M. A few observations were taken at 8, 9, and 10 P.M., which

tend to show that if the period covered by the curves were extended up to 9 P.M. the evening rise might be more marked.



The latrines are in use continuously during the hours of daylight.

In a sewered town the flow of sewage is influenced not only by the use of water-closets but by waste water People bathe and wash clothes, cooking pots, etc., after the morning visit to the closet, so it is probable that the flow in sewers would be rapid and fairly regular up to about 11 A. M., scanty during the middle of the day, and with a tendency to rise from 3 P.M. The septic tanks are fed in this manner.

Manufacture of sewage.—The solid matter of the excreta is partially broken down prior to mixture with the diluting water. The process is not so thorough as that which takes place normally in sewers, so in the mixing chambers the solid particles are rubbed with a broom against the walls. The coarse suspended matter, of which very little is mineral in an artificial sewage, settles very rapidly : it will be remembered that the floor of the mixing chamber is 3" below the invert of the outlet pipe ; to obviate the possibility of the fluid leaving the mixing chambers from being an emulsion minus the heavy suspended matter the contents of the chambers are kept in rotation with wooden paddles.

Objects of septic treatment.—The Royal Commissioners have laid down in their fifth report that the main objects of passing sewage through septic tanks must be looked upon as being :—

the settlement of the suspended matter in the sewage ;

the digestion of as much sludge as possible ; and

the equalisation of the sewage as regards strength.

In the early days of septic tank treatment it was claimed that a sewage so treated was more easily oxidised than a sewage which had been subjected to sedimentation or chemical precipitation. This was the subject of careful investigation by the Royal Commissioners at their experimental installation at Dorking, with the result that the claim was proved to be unjustified for domestic sewages. Similar results for sewages containing trade effluents were obtained by different observers at Rochdale, Leeds, Huddersfield, and at Sheffield.

In working this experimental installation the objects of septic tank treatment as detailed by the Royal Commissioners have been kept in mind, and the result of each experiment gauged by the manner in which they have been attained.

Management of tanks.—For starting a new septic tank two definite recommendations are made :—

1. To dose the tank with septic sludge, prior to admitting sewage.

2. To increase the load gradually.

The former recommendation bears the imprimatur of the Royal Commissioners, and is obviously sound; for, if any virtue lies in septic action the sooner the tank becomes septic the better. The latter recommendation is somewhat indefinite, and it is not clear if it applies to sewages of every strength or only to those of low dilution 5 and 10 gallons.

In starting the 4 septic tanks the following experiments have been or are being carried out :—

Exp. No.	Full load.	Initial load.	Time in reaching full load.
1.	20 gallons	60 gallons	52 days.
2.	do.	40 do.	24 „
3.	do.	20 do.	at once.
4.	15 do.	60 do.	126 days.
5.	do.	20 do.	24 days.
6.	do.	15 do.	at once.
7.	10 do.	40 do.	60 days.
8.	do.	10 do.	at once.
9.	5 do.	5 do.	„

In estimating the results of the experiments attention was directed to the rate of evolution of sulphides (H_2S gas), the rapidity of production of a permanent scum, and the percentage reductions in suspended solids, albuminoid nitrogen, and in the power of absorbing oxygen from acid permanganate. Experiments Nos. 1, 2, and 3 compared.

Sulphuretted hydrogen was produced in 32, 28, and 24 days. Mosquitoes breed with great readiness in sewage; the septic tanks, within a few days of starting work, were covered with a mat of eggs and larvae (anopheline larvae, not only those of N. M. Rossi, were found). The smallest trace of H_2S proved sufficient to kill all larvae, and to drive the adults from the vicinity of the tanks. After cleaning and restarting the tanks the adult mosquitoes returned at once and deposited eggs. The death of the resulting larvae was again synchronous with the evolution of H_2S. It is evident that in a tropical land the production of traces of sulphuretted hydrogen in a septic treatment of sewage is a contingency to be desired.

Scum production.—In experiments Nos. 1 and 2 scum was formed on the 25th day, and in experiment No. 3 on the 20th day. A thick permanent scum is probably as fatal to insect breeding as H_2S, but it must be remembered that the scum on an open tank may disappear at certain seasons of the year. Again if a scum-board is used, the portion of the tank liquor between the board and the outlet wall will be free from scum, and permit of insect breeding in the absence of other inhibitory factors. The percentage reductions in suspended solids, albuminoid N, and in oxygen absorbed are :—

TABLE 1.

——	Expt. 1.	Expt. 2.	Expt. 3.
Suspended solids Total	85	84	78
„ „ Volatile	84	82	80
Albuminoid Nitrogen	73	63	70
Oxygen absorbed 4 hours	61	57	64
„ „ 3 mins.	20	43	48

The inferences from these experiments are that if a septic tank is started with its full load at once the evolution of H_2S, and the production of scum are hastened, while the percentage reductions in the figures for suspended solids, albuminoid nitrogen, and capacity for absorbing oxygen from permanganate are no less than in those tanks in which the full load is reached gradually.

Experiments 4 and 5.—H_2S evolution and scum production were more rapid in expt. 5. The chemical results are not strictly comparable, for the attainment of the full load was very slow (126 days) in expt. 4. The samples for the two experiments were taken under different climatic conditions, during expt. 5 the weather was cool but before the end of expt. 4 the heat was great, giving rise to very active gas evolution. Chemically the septic effluents in expt. 5 are far superior to those in expt. 4: thus the suspended were as ·4 to 21, and oxygen absorbed in 4 hours 7·49 to 11·86. From Dr. Fowler's clarification test it is possible to form an idea of the oxygen absorptive capacity due to heavy suspended solids, fine suspended matter or "colloids", and "crystalloids" respectively. The comparison of these figures for expts. 4 and 5 is of interest:—

TABLE 2.

—	Expt. 4.	Expt. 5.
Heavy suspended solids	5·17	1·37
Fine „ „ (colloids)	4·08	3·49
Crystalloids	2·61	2·63

It can be inferred, therefore, that by gradually increasing the load of a tank up to the maximum, septic action does not increase the matter in crystalloid solution, neither dose it reduce that in fine or colloidal suspension, but that consequent on the more active evolution of gas the heavy suspended matter is increased roughly in proportion to the length of time the tank has been working.

Experiments 6, 7, 8 and 9 are not as yet complete.

Conclusions.—As far as the experiments have gone it is possible to say that there is no evidence in favour of gradually increasing the dose up to the full load in the case of septic tanks destined to deal with sewages of 15 and 20 gallon dilutions.

Method of sampling.—At some moments the fluid in a septic tank is in active ebullition, and at other times at rest. To exemplify the great and rapid variations in the composition of the septic liquor, analyses are given of two samples taken from the same tank, on the same day, but with an interval of five minutes; when sample A was taken the tank was in active ebullition.

TABLE 3.

—	Sample A.	Sample B
Oxygen absorbed 4 hours	31·04	7·15
„ „ 3 mins.	12·59	2·85
Suspended solids Total	220	7
„ „ Volatile	176	7

As it was impossible to take samples during the whole period of daily flow through the tanks, it was decided to adopt a fixed period—7 to 11 A. M. Samples were taken every 10 minutes, and subsequently mixed. These mixed samples do not represent with absolute accuracy the composition of the tank liquor, the figures of analysis are probably rather below than above the mark, because after the night's rest a certain amount of suspended matter collects on that portion of the tank fluid between the scum-board and outlet wall. The portion of tank liquor carrying away this scum is not collected. Subsequent to the wash away of this scum the tank effluent is usually clear for a certain period, due to the effect of the more perfect settlement at night; the rapidity of development of opacity varies with the rate of flow and the activity of gas evolution. It should be remembered that the disturbing influence of the entry of a large volume of fluid is more evident in a small experimental installation, and that it is probable that the sludge is raised to a greater extent than it would be in a larger tank. A consideration of these facts proves the necessity for mixed samples, and the danger of trusting to chance samples.

Experiment 10.—

Strength of sewage	15 gallons.
Capacity of septic tank	625 „
Volume of sewage added daily	625 „
Period of flow	7 A. M. to 5 P. M.
Duration of experiment	32 weeks.

Sampling of the septic tank commenced after the tank effluent became septic. The average figures from the analyses of many mixed samples of sewage are given in table 4. In considering the figures it must be remembered that wide variations in those for suspended solids and albuminoid nitrogen are inevitable in an artificially mixed sewage, owing to the practical impossiblity of obtaining a really good emulsion, and the consequent great difference in the size of the particles of solid matter. The average figure for oxygen absorbed in four hours is also high: these estimations were made at laboratory temperature, which for a considerable period amounted to over 90° F.

TABLE 4.—Average composition of sewage.

—	—	Variation.	No of analyses.
Ammon. N.	1·37	(0 88 to 2·17)	27
Album. N.	3·12	(1·74 to 6·24)	27
Organic N.	6·39	(3·45 to 12·53)	11
O_2 absorbed in 4 hours	25·43	(17·45 to 44)	31
„ „ (settled)	11·08	(6 3 to 23·79)	23
„ „ (clarified)	3·11	(1·06 to 5·22)	20
O_2 absorbed in 3 mins.	7·43	(5·55 to 13 15)	31
„ " after incubation "	10·62	(6·73 to 15·93)	24
Suspended solids Total	124	(75 to 178)	23
„ „ Vol.	98	(42 to 128)	23

Analyses of the septic effluent were made throughout the experiment, but for purposes of description two periods are taken—the final 6 weeks and the initial

10 weeks. During the final 6 weeks the effluent had the following composition :—

TABLE 5.—Septic effluent during the final 6 weeks of work.

—	—	Variation.	No. of analyses.	—
Ammon N.	2·61	(2·02 to 8·0)	6	90 per cent increase.
Album. N.	0·79	(0·6 to 1·3)	6	74 per cent decrease.
O_2 Absorbed in 4 hours	11·86	(10·34 to 13·58)	6	53 " "
" " (settled) ...	6·69	(6·35 to 6·91)	6	39 " "
" " (clarified) ...	2·61	(2·31 to 2·96)	6	16 " "
" in 3 mins.	4·61	(3·99 to 5·22)	6	38 " "
" after incubation ...	5·96	(5·71 to 6·23)	6	
Suspended solids Total	21	(14 to 27)	6	83 " "
" " Vol.	18	(11 to 23)	6	82 " "

The septic effluent gave off a strong odour of sulphuretted hydrogen : it was in mixed samples an opaque fluid with much matter in suspension, which settled very readily : prolonged settlement had no effect on the opacity. The three minutes O_2 absorbed test, before and after incubation, shows its putrescent character : as the septic effluent has putrefied to a certain extent before the application of the test, its power of further putrefaction is less than that of fresh sewage : the capacity for rapid absorption of oxygen is increased on incubation by 29 per cent for septic liquor, and by 43 per cent for its corresponding fresh sewage. It will be noted that the figure for O_2 absorbed in four hours by septic liquor is but slightly higher than that for settled sewage, a fact which is in favour of the inference that septic liquor is sewage minus its heavy suspended matter, but with sulphides added.

TABLE 6.—Dr. Fowler's clarification test :—

Sample.	Shaken. I.	Settled II.	Heavy susp. matter I-II.	Crystalloids clar fied III.	Fine suspended matter or "colloids."
Sewage	25·43	11·08	14·35	3·11	7·97
Septic	11·86	6·69	5·17	2·61	4·08

This test shows that the septic tank has reduced the heavy and fine or "colloidal" suspended matters by 65 per cent and 49 per cent, and the organic matter in crystalloid solution by 16 per cent.

In sewage the ratio of fine to heavy suspended matter is as 1 : 1·9, while in the septic effluent it is as 1 : 1·2 ; that is the proportion of fine to heavy suspended matter is higher in a septic liquor than in its corresponding sewage.

In table 7 are given the average analytical figures for the septic effluent during the inital 10 weeks of working.

TABLE 7.—

—	—	Variation.	No. of analyses.
Ammon. N.	1 98	(1·12 to 2·51)	9
Album. N.	0·75	(0·59 to 0·99)	9
O_2 absorbed in 4 hours	7·49	(5·34 to 10·92)	9
" " (settled)	6·12	(4·2 to 8·05)	9
" " (clarified)	2·63	(2·12 to 3·10)	9
" in 3 mins.	3·55	(1·92 to 4·9)	9
" "	4·84	(3·75 to 5·26)	9
Suspended solids Total	14	(9 to 22)	8
" " Vol.	8	(4 to 11)	8

An interval of 16 weeks elapsed between the taking of the final sample of this series and the first sample of the previous series.

On comparing tables 5 and 7 the points of interest are :—

1. There is little difference in the figures for albuminoid nitrogen.

2. The suspended solids and the oxygen absorptive power increase with prolonged working. (50 per cent and 58 per cent respectively.)

By applying Dr. Fowler's clarification test it is seen that the increase in the oxygen absorptive power is due to the increase in the suspended matter.

TABLE 8.—Clarification test applied to septic effluents.

Source of sample.	Shaken I.	Settled II.	Heavy suspended solids. I-II.	Crystal-loids clarified III.	Fine suspended solids, or "colloids" II-III.
Septic liquor from table 7	7·49	6·12	1·37	2·63	3·49
Septic liquor from table 5	11·86	6·69	5·17	2·61	4·08
Septic liquor during ebullition of tank	20·53	9 33	11·20	2·61	8·59

The noteworthy points brought out by this test are :—

1. The organic matters in crystalloid solution (col. III of table) are not effected by an increase in the activity of septic conditions.

2. The heavy suspended solids are increased in proportion to the activity of gas production.

3. The fine suspended solids or "colloids" are increased, but to a lesser degree.

Scum production. The scum on the inlet chamber was at the end of the experiment 12" in thickness, and practically floating on the surface of the liquid. It was quite inoffensive. The layer exposed to the sun and air was of an earthy nature, on which plants such as tomatoes grew well. Over the main body of the tank the scum during the hot dry weather was of a tenacious leathery character, and attained its maximum thickness of 3". Up to the onset of the rains the scum was infiltrated with moulds, to the growth of which Professor Dr.

Dunbar attributes its tenacity. After a heavy shower of rain the surface of the scum became smooth, and of a dark shining appearance: continuous rain resulted in the disappearance of the scum. The disintegration of scum, which is probably associated with the death of the moulds, seems to depend on the thickness of the scum, for that portion on the inlet chamber showed no tendency to dissolution. After removal from the tank the scum was placed on the ground in a heap about 6" thick; there was no appreciable smell. Blue-bottles settled on the scum for about one hour after its deposit on the ground, but apart from this one observation the scum seemed to have no attraction for flies. In the scum on the tank the larvae of insects were found; these were bred out and identified by Captain Morison, I M.S.

Deposit of sludge.—After the removal of the liquid 12" of sludge were found at the outlet end and 14" at the inlet end of the tank. The sludge was not offensive, and was composed of fine dark particles. The surface of the sludge was level, the absence of accumulation at any spot shows that the sludge can flow to a chamber at the inlet end of the tank, and from thence a sludge valve.

Conclusions from experiment.—The evolution of sulphuretted hydrogen in a septic tank treating a 15 gallon sewage under the conditions of the experiment, is very marked, and liable to cause considerable nuisance.

2. The heavy suspended matter in the tank effluent increases with the length of time the tank has been working.

3. There is not a proportionate increase in the fine suspended matter or "colloids."

4. Prolonged working of the tank does not increase the organic matter in crystalloid solution.

5. Great daily variations in the suspended matter in the effluent are caused by changes in the rate of evolution of gases.

6. To prevent clogging of filters some secondary process for removing these suspended solids is necessary.

Experiment 11.—The conditions the same as for experiment 10: a hydrolytic tank is added for the removal of the suspended matter from the septic liquor. Duration of experiment—11 weeks.

Analyses were made of the hydrolytic tank effluent; the figures are gathered into 2 groups—(*a*) those for samples taken within 3 days of starting or restarting the tank after cleaning; (*b*) those for samples taken at a later period. The figures for samples (*a*) are compared with those for the corresponding septic liquor in table 9.

TABLE 9 —Septic and hydrolytic tank effluents.

Average of 6 samples.	Septic effluent.	Hydrolytic tank.	Per cent decrease.
Albuminoid Nitrogen	0·75	0·515	30
O. absorbed in 4 hours	7·49	5·66	24
„ „ „ clarified	2 63	2·82	...
„ „ 3 minutes	3·55	3·59	...
Suspended solids Total	14	9	35
„ „ Volatile	8	4	50

After the tanks were working for over 3 days it was found that the evolution of gas raised large particles of sludge, which left the tank with the effluent. In appearance the hydrolytic tank effluent was distinctly worse than the septic effluent, and the analyses given in table 10 bear out these observations.

TABLE 10.—Septic and Hydrolytic tank effluents period (b).

Average of 5 samples.	Hydrolytic tank.	Per cent increase.
Albuminoid Nitrogen	0 74	...
O. absorbed in 4 hours	9·8	30
„ „ „ (settled)	7·9	25
„ „ „ (clarified)	3·03	...
„ „ 3 minutes	4·09	15
Suspended solids Total	17	21
„ „ Volatile	12	50

Conclusions from experiment :—

1. The hydrolytic tank is effective in removing suspended matter from septic effluents until the evolution of gas raises particles of sludge.

2. In climatic conditions such as exist in Poona, a hydrolytic tank will require cleaning about twice in a week to work in an efficient manner.

Experiment 12.—Conditions the same as for experiment 10. To prevent the particles of sludge from being blown into that portion of the tank between the scum-board and the outlet wall an iron flange, sloped downwards at an angle of 45, was fixed to the lower end of the scum-board. This device was found effective in the experiments performed at Dorking, by Mr. Eric Richards, on behalf of the Royal Commissioners on sewage disposal Comparative analyses are given in table 11; the figures are not strictly comparable, for the two effluents were taken from different tanks, but both working at the same time.

TABLE 11.—Figures the average of 6 analyses.

Average of 6 samples.	Septic effluent	Hydrolytic tank.	Per cent. decrease
Albuminoid Nitrogen	0·77	0·62	19
O. absorbed in 4 hours	9 68	8 59	11
„ „ „ (settled)	6·41	5·94	7
„ „ „ (clarified)	2·62	2·49	...
„ „ 3 minutes	4·08	3·37	17
Suspended solids Total	20	17	15
„ „ Volatile	16	14	12

The figures are disappointing; at the start of the experiment the suspended matter was arrested efficiently, and there was no accumulation of scum on the

surface of the fluid between the scum-board and the outlet wall after the night's rest. The comparative failure of the experiment was due to the faulty fixation of the flange to the scum-board; many spaces developed through which particles of sludge were blown. It is hoped that it will be possible to repeat this experiment with a flange well made and properly fitted.

Experiment 13.—Conditions as for experiment 12: 3 skeleton wooden frames or "colloiders" are introduced into the tank.

Duration of experiment 12 weeks, divided into two periods of 6 weeks; the first period is called A, and the second B.

In table 12 a comparison is made between the effluent for A and the septic tank effluent before the introduction of "colloiders."

TABLE 12.—Septic effluent compared with effluent for period A.

——	S. T.	A.	Decrease.
Albuminoid Nitrogen	0·62	0·54	13
O. absorbed in 4 hours	8·59	6·64	22
" " " (settled)	5·94	5·32	10
" " " (clarified)	2·49	2·61	...
" " 3 minutes	3·37	2·85	15
Suspended solids Total	17	10	41
" " Volatile	14	8	42

It is evident that during the first period the introduction of colloiders assisted in the sedimentation of suspended matter. The analyses of samples taken during the final 6 weeks show that this action is counteracted by the raising of sludge by gas evolution The effluents for the two periods are compared in table 13.

TABLE 13.—Effluent for periods A and B compared.

——	A.	B.	Increase B over A.
Albuminoid Nitrogen	0·54	0·63	17
O. absorbed in 4 hours	6·64	9·77	47
" " " (settled)	5·32	5·66	6
" " " (clarified)	2·61	2·3	...
" " 3 minutes	2·85	3·74	31
Suspended solids Total	10	24	140
" " Volatile	8	22	175

The figures show that during the period B there is a very marked rise in the suspended solids and the capacity for absorbing oxygen from acid permanganate. Dr. Fowlers' clarification test analyses the increase in the suspended solids.

TABLE 14.—Dr. Fowler's clarification test.

Sample.	Shaken. I	Settled. II	Heavy suspended solids. I—II	Clarified Crystalloids. III	Fine suspended solids "colloids." II—III
Septic effluent ...	8·59	5·94	2·65	2·49	3·45
Effluent A	6·64	5·32	1·62	2·61	2·71
Effluent B	9·77	5·66	4·11	2·3	3·36

On comparing effluent A with the septic effluent it is seen the percentage reduction effected by the "colloiders" in heavy and fine suspended matters respectively are 40 and 21.

Effluent A shows an increase over effluent B of 153 per cent for the heavy suspended solids and of 24 per cent for the fine or "colloids." It is evident that the main work of the so-called colloiders is on the heavy suspended matter.

Conclusions from experiment :—

(1) Colloiders do assist in the settlement of suspended matter, more especially the heavy particles.

(2) The action is masked as the age of the tank increases, and the consequent raising of the sludge by gas evolution.

(3) The term "colloiders" is apt to be misleading.

Experiment 14.—Conditions the same as for experiment 10.

The septic effluent passed through a "macerating" tank, filled with overburnt brick broken to pieces of from 1½" to 2½" in diameter. The tank was fed daily with 480 gallons of septic effluent per cube yard of material. Duration of experiment 20 weeks.

The average composition of the macerating tank effluent is given in table 15.

TABLE 15.

——	—	Variation.	No. of analyses.
Ammon. N.	3·42	(2·7 to 4·4)	18
Album. N.	0·42	(0·3 to 0·56)	18
O. absorbed in 4 hours	6·12	(4·2 to 8·05)	18
" " " (settled)	5·57	(3·79 to 7·32)	18
" " " (clarified)	2·82	(2·29 to 3·86)	18
" " 3 minutes	2·73	(1·53 to 3·42)	18
" " "	3·84	(3·02 to 4·73)	18
Suspended solids Total	6	(3 to 10)	18
" " Volatile	5	(3 to 7)	18

To show clearly the work done by the macerating tank a table is given with the figures for samples taken during the final 6 weeks of work, and for septic tank samples taken at the same time and under similar conditions. In reading the table it should be remembered that the macerating tank deals with all the suspended matter which leaves the septic tank, while the samples of septic liquor contain no portion of the scum which leaves with the first flow of effluent each day.

TABLE 16.—Comparison of septic and macerating tank effluents.

—	Septic.	Macerating.	—
Ammon. N.	2·61	3·32	27 % increase.
Album N.	0·79	0·43	45 % decrease.
O. absorbed in 4 hours	11·86	6·42	46 % "
" " " (settled)	6·69	5·50	18 % "
" " " (clarified)...	2·61	2·77	...
" " 3 minutes	4·61	2·84	38 % "
" " " (incubated)	5·96	4·84	...
Suspended solids Total	21	8	62 % "
" " Volatile	18	6	66 % "

The macerating tank was untouched throughout the experiment, and consequently required no supervision.

TABLE 17.—Dr. Fowler's clarification test.

Sample.	Shaken. I	Settled. II	Heavy suspended solids. I-II	Crystalloids clarified. III	Fine suspended matter "Colloids." II-III
Septic	11·86	6·69	5·17	2·61	4·08
Macerating	6·42	5·50	0·92	2·77	2·73

Thus the macerating tank has caused percentage reductions in heavy and fine suspended matters of 82 and 33 respectively.

The oxygen absorptive of the shaken macerating tank effluent is practically that of the settled septic liquor: it was noted previously (page 11) that the shaken septic effluent is the equivalent of settled sewage.

Conclusions from experiment :—

1. The macerating tank removes efficiently the heavy suspended matter from a septic tank effluent, and to a less degree the fine or colloidal solids.
2. The removal of fine suspended matter is apparently greater than it actually is, owing to the fact that the oxygen absorptive power of sulphides, which are destroyed in the clarification process, is included in the figure for "colloids."
3. Owing to the increased production of sulphuretted hydrogen the use of a macerating tank is likely to augment the nuisance from smell.
4. The chief action of the macerating tank is mechanical, so a better name would be straining tank—*vide* 5th report of the Royal Commission, page 29.

5. The variations in composition of the septic liquor, due to the raising of sludge by gas evolution and the rapidity of flow through the tank are counteracted by the macerating tank, the effluent from which exhibits little daily variation.

Experiment 15.—Conditions as for experiment 10: volume of sewage added daily 1,100 gallons.

This experiment is not concluded.

Experiment 16.—Septic liquor from experiment 15 passed through a macerating tank: volume of liquor per cube yard of material 850 gallons.

This experiment is not concluded.

Experiment 17.—

	Gallons.
Strength of sewage	20
Capacity of septic tank...	625
Volume of sewage added daily	625
Period of flow	7 A.M. to 5 P.M.
Duration of experiment	11 weeks.

The tank effluent was septic before the start of the experiment. The average composition of sewage is given in table 17.

TABLE 17a—Composition of 20 gallon sewage.

—	—	Variation.	Number of analyses.
Ammon. N.	1·02	(0 81 to 1·66)	25
Album. N.	2·25	(1·98 to 2·76)	25
O. absorbed in 4 hours	18·01	(12·7 to 26·5)	28
" " " (settled)	8 45	(5·13 to 14·5)	28
" " " (clarified)	2·59	(1 72 to 5·68)	28
" " 3 minutes	4·78	(2·64 to 7·75)	28
" " " (incubated)	8·21	(4·13 to 10·13)	28
Organic Nitrogen	4·58	(3·65 to 5 54)	13
Suspended solids Total	95	(70 to 155)	20
" " volatile	70	(49 to 120)	20

During the final 6 weeks of the experiment the average composition of the septic liquor, and the percentage reduction on the sewage figures are given in table 18.

TABLE 18.—Septic effluent compared with sewage.

—	Septic.	Variation.	Number of analyses.	—
Ammon. N.	2·19	(1·76 to 2·43)	6	114% increase
Album. N.	0·66	(0·40 to 0·90)	6	70% decrease
O. absorbed in 4 hours	6·77	(5·54 to 8·06)	6	62% ,,
,, ,, ,, (settled) ...	4·89	(3·33 to 7·07)	6	42% ,,
,, ,, ,, (clarified) ...	2·3	(1·99 to 2·52)	6	11% ,,
,, ,, 3 minutes ...	3·37	(2·61 to 4·29)	6	29% ,,
,, ,, ,, (incubated) ...	4·52	(4·08 to 4·74)	6	...
Suspended solid Total	12	(9 to 16)	6	87% ,,
,, ,, Volatile	8	(4 to 11)	6	88% ,,

Throughout the experiment there was marked evolution of sulphuretted hydrogen.

TABLE 19.—Dr. Fowler's clarification test.

Sample.	Shaken. I	Settled. II	Heavy suspended solids. I-II	Crystalloids clarified. III	Fine suspended matter "Colloids." II-III
Sewage	18·01	8·45	9·56	2·59	6·97
Septic liquor	6·77	4·89	1·88	2·3	2·59

The percentage reductions effected by the septic tank in the heavy and fine suspended matter are 80 and 62 respectively.

The ratio of fine to heavy suspended matter is for sewage 1 : 1·4 and for the septic liquor 1 : 0·72.

Experiment 18—Conditions as for experiment 17 : 800 gallons of sewage added daily : duration of experiment 12 weeks.

TABLE 20.—Average composition of septic effluent.

—	—	Variation.	—
Ammon. N.	2·02	(1·01 to 2·51)	9
Album. N.	0·64	(0·45 to 0·89)	9
O. absorbed in 4 hours	6·94	(5·88 to 7·94)	9
,, ,, ,, (settled)	5·56	(3·79 to 6·79)	9
,, ,, ,, (clarified)	2·45	(1·59 to 3·01)	9
,, ,, 3 minutes	3·13	(2·78 to 3·66)	9
,, ,, ,, (incubated)	4·77	(4·13 to 5·46)	9
Suspended solids Total	13	(11 to 16)	8
,, ,, Volatile	9	(8 to 10)	8

There is little difference between these figures and those for the septic effluent in the previous experiment.

Experiment 19.—Conditions the same as for experiment 17: volume of sewage added daily 1060 gallons: duration of experiment 14 weeks. The average composition of samples of septic liquor taken during the final 6 weeks of the experiment is given in table 21.

TABLE 21.—Composition of septic effluent during final 6 weeks.

——	——	Variation.	No. of analyses.
Ammon. N.	1·99	(1·3 to 2·4)	6
Album. N.	0·55	(0·45 to 0·69)	6
O. absorbed in 4 hours	6·88	(5·79 to 8·04)	6
„ „ „ (settled)	4·31	(3·14 to 6·01)	6
„ „ „ (clarified)	2·39	(1·6 to 3·55)	6
„ „ „ 3 mins.	3·33	(2·99 to 3·82)	6
„ „ „ (incubated)	5·99	(5·72 to 6·54)	6
Suspended solids Total	15	(14 to 16)	3
„ „ Volatile	13	(12 to 16)	3

The figures for suspended solids are probably too low in these three experiments, for it was found again that during the night's rest scum accumulated on the surface of the fluid between the scum-board and the outlet weir. The evolution of gas was at times very violent, and occurred at irregular intervals; allowance for this could not be made in making the samples.

TABLE 22.—Dr. Fowler's clarification test applied to the septic liquors of experiments 17, 18 and 19.

Sample.	Shaken. I	Settled. II	Heavy suspended solids. I—II	Crystalloids clarified. III	Fine suspended matter "Colloids." II—III
Experiment 17 ...	6·77	4·89	1·98	2·3	2·59
Experiment 18 ...	6·94	5·56	1·38	2·45	3·11
Experiment 19 ...	6·88	4·31	2·57	2·39	1·92

The remarks made on scum production for the tank dealing with a 15 gallon sewage are applicable to this tank also.

The nuisance from the smell of sulphuretted hydrogen was somewhat less under the conditions of experiment 19 in spite of the increased age of the tank.

Sludge production.—After completion of experiment 19 the septic tank was cleaned: 13" of sludge was found at the outlet end, and 15" at the inlet end. The sludge was inoffensive, and was in character similar to that found in the

tank dealing with a 15 gallon sewage: it would flow easily through a sludge valve.

Conclusions from experiments 17, 18 and 19.—Same as those for experiment 10 with this addition:—

7. An increase up to 70 % in the volume of sewage added does not materially alter the character of the septic liquor, except in a possible reduction in the quantity of sulphuretted hydrogen evolved.

Experiment 20.—Conditions as for experiment 18: septic liquor passed through a macerating tank: volume of liquor per cube yard of material, 620 gallons. Duration of experiment 12 weeks. The smell of sulphuretted hydrogen in the macerating tank effluent was very marked.

TABLE 23.—Average composition of macerating tank effluent.

—	—	Variation.	No. of analyses.	—
Ammon. N.	2·43	(2·06 to 3·21)	14	20% increase.
Album. N.	0·30	(0·22 to 0·44)	14	53% decrease.
O. absorbed 4 hours	4·84	(3·26 to 6·31)	14	30% "
" " (settled) ...	4·74	(3·23 to 6·31)	14	14% "
" " (clarified) ...	1·88	(1·29 to 3·04)	14	23% "
" 3 mins.	2·24	(1·41 to 3·49)	14	28% "
" " (incubated) ...	3·41	(2·96 to 4·34)	14	...
Suspended solids Total	4	(2 to 6)	12	69% "
" " Volatile ...	3	(2 to 5)	12	66% "

TABLE 24.—Dr. Fowler's clarification test.

Sample.	Shaken. I	Settled. II	Heavy suspended solids. I—II	Crystalloids clarified. III	Fine suspended matter "Colloids." II—III
Septic tank	6·94	5·56	1·38	2·45	2·59
Macerating tank ...	4·84	4·74	0·10	1·88	2·86

The percentage reduction effected by the macerating tank in the heavy suspended matter is 92. The fine suspended matters or colloids are apparently increased, but this may be due to the increase in the amount of sulphides, caused by the prolongation of septic conditions in the macerating tank.

Conclusions from experiment 20.

1. The macerating tank removes efficiently the heavy suspended matter from a septic effluent obtained under the conditions of the experiment.
2. The risk of nuisance from the evolution of sulphuretted hydrogen is increase.

Experiment 21.—Conditions as for experiment 19: passage of septic liquor through a macerating tank: volume of septic liquor per cube yard of material, 850 gallons. Duration of experiment 14 weeks.

TABLE 25.—Average composition of macerating tank effluent.

—	—	Variation.	No. of analyses.	—
Ammon. N.	2·44	(2·06 to 2·66) ...	14	22 per cent increase.
Album. N.	0·26	(0·25 to 0·31) ...	14	53 „ decrease.
O. absorbed 4 hours	4·83	(4·06 to 5·16) ...	14	30 „ „
„ „ (settled) ...	4·38	(4·06 to 4·81) ...	14	...
„ „ (clarified) ...	1·77	(1·41 to 2·01) ...	14	25 per cent decrease.
„ 3 mins.	1·46	(1·41 to 1·52) ...	14	37 „ „
„ „ (incubated) ...	3·95	(2·83 to 4·34) ...	14	...
Suspended solids Total	5	(4 to 6) ...	14	66 per cent decrease.
„ „ Volatile	4	(2 to 5) ...	14	69 „ „

The uniform composition of the effluent is noteworthy.

TABLE 26.—Dr. Fowler's clarification test.

Sample.	Shaken. I	Settled. II	Heavy susp. solid. I-II	Crystalloids clarified III	Fine susp. solid "Colloids." II-III
Septic liquor	6·88	4·31	2·57	2·39	1·92
Macerating tank liquor	4·83	4·38	0·45	1·77	2·61

The percentage reduction in the heavy suspended matter effected by the macerating tank is 82; the increase in the fine suspended matter is rather greater than in the previous experiment—30 per cent against 10 per cent—the explanation is probably to be found in the evolution of sulphuretted hydrogen.

Conclusions.—Same as for experiment 20.

Experiment 22.—

Strength of sewage	8 gallons.
Capacity of septic tank	525 „
Volume of sewage added daily	525 „
Period of flow	7 a.m. to 5 p.m.
Duration of experiment	8 weeks.

This was intended for a 10-gallon sewage, but a mistake in calculation was made.

TABLE 27.—Average composition of the sewage.

—	—	Variation.	No. of analyses.
Ammon. N.	1·92	(1·6 to 2·22) ...	10
Album. N.	4·14	(3·2 to 5·1) ...	10
Organic N.	9·24	(7·97 to 11·44) ...	6
O. absorbed in 4 hours	36·38	(20·98 to 54·2) ...	12
„ „ „ (settled)	15·01	(9·25 to 23·55) ...	12
„ „ „ (clarified)	3·56	(2·75 to 13·4) ...	12
„ „ 3 mins.	11·16	(7·61 to 13·4) ...	12
„ „ „ (incubated)	13·22	(10·2 to 15·6) ...	12
Suspended solids Total	202	(132 to 314) ...	11
„ „ Volatile	178	(111 to 264) ...	11

TABLE 28.—Average composition of septic tank effluent.

—	—	Variation.	No. of analyses.	—
Ammon. N.	3·57	(3·01 to 3·94) ...	6	86 per cent increase.
Album. N.	0·86	(0·66 to 0·94) ...	6	80 „ decrease.
O. absorbed 4 hours	10·46	(8·45 to 11·72) ...	6	71 „ „
„ „ (settled) ...	8·24	(7·1 to 9·7) ...	6	45 „ „
„ „ (clarified) ...	3·34	(2·3 to 4·4) ...	6	6 „ „
„ 3 mins.	4·29	(3·6 to 4·8) ...	6	61 „ „
„ „ (incubated) ...	6·6	(4·9 to 7·1) ...	6	...
Suspended solids Total	18	(12 to 22) ...	6	90 per cent decrease.
„ „ Volatile ...	14	(8 to 16) ...	6	94 „ „

The figures for the septic effluent are not strictly comparable with those for sewage, as the analyses were not made under similar conditions; again the experiment was of too short duration to permit of accurate deductions. The suspended matters were rising so rapidly that it was decided to pass the septic liquor through a macerating tank. The experiment is recorded to show that a septic liquor, obtained under the conditions of this experiment, is strong from the first.

Experiment 23.—Conditions as for experiment 22: the septic liquor is passed through a macerating tank filled with overburnt brick broken into fragments of from $1\frac{1}{2}$ to $2\frac{1}{2}''$; volume of septic liquor per cube yard of material, 800 gallons. Duration of experiment 10 weeks.

TABLE 29.—Average composition of the macerating tank effluent.

——	—	Variation.	No. of analyses.	—
Ammon. N.	3·74	(3·29 to 4·21) ...	8	5 per cent increase.
Album. N.	0·68	(0·48 to 0·91) ...	8	20 „ decrease.
O. absorbed 4 hours	8·03	(6·58 to 9·66) ...	9	23 „ „
„ „ (settled) ...	6·4	(5·31 to 8·71) ...	9	22 „ „
„ „ (clarified) ...	3·67	(2·2 to 4·63) ...	9	...
„ 3 mins.	4·06	(3·58 to 4·48) ...	8	5 per cent decrease.
„ „ (incubated) ...	5·01	(3·88 to 6·17) ...	8	...
Suspended solids Total	8	(3 to 11) ...	5	55 per cent decrease.
„ „ Volatile ..	6	(2 to 9) ...	5	57 „ „

TABLE 30.—Dr. Fowler's clarification test.

Sample.	Shaken. I	Settled. II	Heavy suspended solid. I-II	Crystalloids clarified. III	Fine suspended solids "Colloids." II-III
Sewage	36·46	15·01	21·37	3·56	11·45
Septic liquor	10·46	8·24	2·22	3·34	4·90
Macerating „	8·03	6·4	1·63	3·67	2·73

Passage of sewage through a septic tank, and of the septic through a macerating tank does not appear to alter the amount of organic matter in crystalloid solution. The septic tank effects a reduction on the sewage in the heavy suspended matters of 89 per cent, and in the fine suspended matter of 57 per cent. The macerating tank reduces the heavy and fine suspended matters in the septic effluent by 22 per cent and ·44 per cent respectively. Proportion of fine to heavy suspended matters—sewage 1 : 1·9, septic liquor 1 : 0·45, macerating tank liquor 1 : 0·59. The septic and macerating tank liquors smelt strongly of sulphurretted hydrogen.

Conclusions from experiment.—

1. The macerating tank produces an effluent of uniform composition.
2. It efficiently removes the suspended matter from a septic liquor.
3. It does not increase the organic matter in crystalloid solution.
4. The ratio of fine to heavy suspended matter is high in the macerating tank liquor.

Experiment 24.—In continuation of experiment 22; same strength of sewage; volume of sewage added daily—625 gallons. Duration of experiment 20 weeks.

TABLE 31.—Average composition of septic effluent, compared with figures for sewage.

—	—	Variation.	Number of analyses.	—
Ammon. N.	4·03	(3·2 to 4·94)	15	110 % inc.
Album. N.	0·96	(0·76 to 1·12)	15	77 % dec.
O. absorbed 4 hours	13·33	(10·37 to 17·2)	16	63 % „
„ „ (settled) ...	8·48	(5·88 to 11·41)	16	43 % „
„ „ (clarified) ...	2·64	(2·14 to 3·10)	16	25 % „
„ 3 mins.	4·29	(3·06 to 4·88)	16	61 % „
„ „ (incubated) ...	6·06	(4 88 to 6·91)	16	...
Suspended solids Total ...	30	(13 to 49)	6	80 % dec.
„ „ Volatile ...	24	(9 to 40)	6	86 % dec.

The smell of sulphuretted hydrogen was well marked throughout the experiment. The evolution of gas was at times very violent; a chance sample taken during one of these periods of tank ebullition gave the following figures on analyses :—

TABLE 32.—Analysis of chance sample taken during ebullition.

O. absorbed in 4 hours	31·94
„ „ (settled)	9·04
„ „ (clarified)	2 62
„ 3 mins	12·59
Suspended solids Total	220
„ „ Volatile	176

These periods of ebullition are more frequent and violent during the hot season, but occur daily throughout the year, at irregularly recurring intervals. During these periods the septic liquor may be as strong as the sewage entering the tank.

The application of Dr. Fowler's classification test is of interest.

TABLE 33.—Dr. Fowler's clarification test.

Sample.	Shaken. I	Settled. II	Heavy suspended solids. I—II	Crystalloids clarified. III	Fine suspended solids "Colloids." III
Sewage	36·38	15·01	21·37	3·56	11·45
Septic liquor experiment 22.	10·46	8·24	2·22	3·34	4·90
Septic liquor experiment 24.	13·33	8·48	4·85	2·64	5·84
Septic liquor experiment 24 during ebullition.	31·94	9·04	22·00	2·62	6·42

The septic effluent in experiment 24 has effected reductions in the heavy and fine suspended matter, as compared with the figures for sewage, of 77 per cent and 50 per cent respectively. On comparing this effluent with that for experiment 22 it is seen that there is a rise in the heavy suspended solids of 118 per cent, and in fine or colloidal matter of 19 per cent. The increase in the oxygen absorptive power of the sample of septic effluent taken during the ebullition of the tank is due almost entirely to a rise in the heavy suspended solids. There is no increase in the organic matter in crystalloid solution caused by septic action. The ratio of fine to heavy suspended matter is for sewage 1 : 1·9: septic liquor experiment 22-1 : 0·45 ; for septic liquor experiment 24-1 : 0·83; and for septic liquor during tank ebullition 1 : 3·4.

Conclusions.—The septic liquor is liable to give rise to some nuisance owing to the evolution of sulphuretted hydrogen.

2. There is a wide daily variation in the composition of the septic liquor.

3. This variation is due mainly to the raising of heavy suspended matter by gas.

4. Apart from these periods of gas production, the septic liquor contains a larger proportion of fine than heavy suspended matter.

5. An effluent so rich in suspended matter is likely to clog a filter, so some secondary process for the removal of matters in suspension is desirable.

Experiment 25.—Conditions as for experiment 24: septic liquor passed through a macerating tank filled with road metal, broken into fragments 1" to 1½" in diameter. Volume of septic effluent per cube yard of material, 950 gallons. Duration of experiment 8 weeks.

The experiment was closed at the end of 8 weeks, because the accumulation of sludge at the bottom of the macerating tank was blocking the inlet pipe, and so damming back the fluid in the septic tank. Throughout the experiment the evolution of sulphuretted hydrogen was marked.

TABLE 34.—Average composition of macerating tank effluent, and compared with the corresponding septic liquor.

—	—	Variation.	Number of analyses.	—
Ammon. N.	3·95	(2·61 to 5·06)	9	...
Album. N.	0·52	(0·42 to 0·65)	9	45 % decrease.
O. absorbed 4 hours	7·52	(6·38 to 8·88)	12	43 % „
„ „ (settled) ...	6·59	(5·20 to 7·86)	12	21 %
„ „ (clarified) ...	2·86	(2·54 to 4·17)	12	...
„ 3 mins.	3·01	(2·26 to 3·9)	8	30 % „
„ „ (incubated) ...	4·21	(3·76 to 4·54)	8	...
Suspended solids Total ...	7	(6 to 8)	8	76 % „
„ „ Volatile ...	5	(4 to 7)	8	79 % „

The composition of the macerating tank effluent was markedly uniform, there were no periods of voilent flushing out of sludge: judging by the sense of smell the evolution of sulphuretted hydrogen was increased.

TABLE 35.—Dr. Fowler's clarification test.

Sample.	Shaken. I	Settled. II	Heavy suspended solids. I—II	Crystalloids clarified. III	Fine suspended solids "Colloids." II—III
Septic effluent ...	13·38	8·48	4·85	2·64	5·84
Macerating effluent ...	7·52	6·59	0·93	2·86	3·73

The percentage reductions in the heavy and fine suspended matters effected by the macerating tank are 80 and 36.

Ratio of fine to heavy suspended matter is for septic liquor 1 : 0·83, and for macerating tank effluent 1 : 0·25.

Experiment 26.—Conditions the same as for experiment 25 : the macerating tank filled with overburnt brick broken to fragment of the same size: duration of experiment 12 weeks.

Six weeks after the start of the experiment it was noticed that the effluent from the septic tank was being dammed back ; the cause was the same as in the previous experiment—blocking of the inlet pipe by an accumulation of sludge. In these tanks the invert of the inlet pipe is on a level with the floor of the tank; this is a mistake, it (the inlet pipe) should open just below the false bottom, with a clear drop of several inches between the invert and the true floor of the tank. With this arrangement the sludge will settle better, and the interval between cleansing the tank may be prolonged.

TABLE 36.—Average composition of macerating tank effluent.

—	—	Variation.	No. of analyses.
Ammon. N.	3 99	(3·3 to 4·86)	10
Album. N.	0·48	(0·41 to 0·58)	10
O. absorbed in 4 hours	6·84	(5·55 to 8·13)	10
" " (settled)	6·17	(5·18 to 7·7)	10
" " (clarified)	2·61	(2·06 to 3·03)	10
" 3 mins.	2·89	(2·19 to 3·8)	10
" " (incubated)	4·44	(3·2 to 6·23)	10
Suspended solids Total	9	(5 to 18)	8
" " Volatile	7	(4 to 11)	8

TABLE 37.—Dr. Fowler's clarification test.

Sample.	Shaken. I	Settled. I	Heavy suspended solids. I—II	Crystalloids clarified. III	Fine suspended solids. II—III
Septic effluents ...	13·33	8·48	4 85	2 64	5·84
Macerating effluents experiment 25.	7·52	6·59	0·93	2·86	3 73
Macerating effluents experiment 26.	6·84	6 17	0·67	2·61	3·56

The two macerating tank effluents are very similar.

Conclusions from experiments 25 and 26.—

1. The conclusions at the end of experiment 14 may be repeated.
2. Macerating tanks to deal with strong septic liquors of an 8-gallon sewage, and fed at the rate of 950 gallons per cube yard of material require cleaning frequently, say once in 4 weeks.
3. The macerating tank may be filled with any kind of material provided it will weather.
4. The intervals between cleansing may be lengthened by lowering the floor of the tank below the invert of the inlet pipe.

Experiment 27.—Conditions as for experiment 22: volume of sewage added daily 350 gallons.

Experiment not concluded.

Experiment 28.—Conditions as for experiment 27: septic liquor passed through macerating tank: volume of septic liquor per cube yard of material 530 gallons.

Experiment not concluded.

Experiment 29.—Conditions as for experiment 17: strength of sewage 5 gallons.

Experiment not concluded.

Experiment 30.—Conditions as for experiment 29: septic liquor passed through macerating tank: volume of septic liquor per cube yard of material 480 gallons.

Experiment not concluded.

Experiment 31.—

Strength of sewage	...	...	...	5 gallons.
Capacity of septic tank	...	...	...	525 ,,
Volume of sewage added daily	...	...	...	175 ,,

Experiment not concluded.

Experiment 32.—In this experiment, which is simply a record of temperatures, the idea is to throw some light on the influence of sunheat on the temperature of the septic liquor. Some authorities have stated that a septic tank is inapplicable to tropical countries on account of the heat.

The temperatures of the septic liquor, and of water contained in a masonry tank of the same depth as the septic tank, were taken twice daily at a depth of two feet: the figures obtained represent approximately the daily maxima and minima.

During the period of observation, 1st of March to 15th June, the daily maximum air temperature varied from 98° F to 112° F, a difference of 14 degrees: in the septic tank the variation was between 84° F and 92° F, a difference of 8 degrees: in the water there was a difference of 16 degrees, 78° F to 94° F. Although the temperature of the septic fluid rose with that of the air, the daily rise was very small —1°F— : that is the septic liquor was kept at an even temperature, never too high for bacterial life. The daily variation in the case of the water amounted to 6° F, and in the air 30°F.

The object in chief of septic treatment is the removal of suspended matters : the experiments detailed show clearly that this object is in part defeated by the raising of sludge by gas: gas production is more active in hot weather, so it is

clear that a high air temperature is not favourable to septic treatment. The experiments show also that the suspended matter in septic liquor can be removed by suitable secondary tanks; consequently high air temperature is not necessarily a contra-indication to the use of septic tanks, it can only be called a disadvantage.

Summary—

1. Septic tank treatment does lead to settlement of solids.
2. Gas evolution interferes with settlement by raising large particles of sludge.
3. The strength of septic liquor is not even owing to this active gas production.
4. The strength of the septic liquor is equalised, and the bulk of the suspended matter removed by a macerating tank.
5. The nuisance from sulphuretted hydrogen is marked; this may prove of import in a small installation for a private house or public building: the experiments conducted at Dorking, for the Royal Commission, have shown that the smell can be removed by the addition of lime to the effluent, while a further advantage results from the precipitating action of the chemical.
6. It was impossible to estimate with any accuracy the activity of the tanks as regards sludge digestion. The great variations in the amount of suspended matter leaving the tanks during the irregularly recurring periods of ebullition proved an insuperable difficulty.

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PERCOLATING FILTERS

BY

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On the bottom of each filter was placed a layer of smooth hard stones 3" in diameter, over this 6' 6" of over-burnt brick broken into fragments 1½" to 2½" in diameter, overlying this for 2' the same material in pieces 1" to 1½" it was intended to have a 6" layer of fragments ½" to 1", this proved impossible. The grading was not absolutely accurate, only approximate. Much of the material was of poor quality, and weathered very badly. Distribution was by means of perforated iron trays.

In the succeeding experiments the figures for the strength of the septic liquors are calculated from the formulae arrived at by Doctor G. McGowan. The formula used is (Ammon + Organic N. × 4·5) + (Ox. abs. in 4 hours × .6·5). Doctor McGowan used strong permanganate in his calculations, in this laboratory the weak permanganate has been used: the ratio of the figure obtained from weak to that from strong permanganate is as 1: 1·6. The actual "figures for strength represent parts by weight of oxygen required to oxidize 100,000 parts" of the liqour. The units of purification are calculated by the method of Doctor G. McGowan and Mr. Colin C. Fry. They give a formula (Ammon + Organic N. × 4·5) + (Vol. Susp. Solids × 2)—(Nitric N. × 3)—from which the oxidizability of the effluent can be calculated. The figure so obtained represents the number of parts by weight of oxygen which are still required to oxidize fully 100,000 parts of effluents. "The number of units of purification is obtained by deducting from the 'strength' figure of the septic liquor passing on to the filter the 'strength' or oxidizability figure of the effluent, and multiplying the figure so obtained, which represents the amount of oxygen used up, by the number of gallons treated per cube yard of filter per day." The authors of the formula have pointed out that it is only "meant to apply in the case of good, or at all events of fairly good, effluent." In the case of a bad effluent the results are liable to be misleading, for if the rate of flow through the filter is increased, the greater is the number of units of purification.

Experiment 33.—Septic effluent from experiment 13.

Dilution of sewage—15 gallons—"colloiders" in septic tank: strength of septic liquor—103·2—: rate of filtration—100 gallons per cube yard daily: surface area of filter 3 square yards: depth of material used 5' : one cube yard of filtering material deals with the excrement of 8 persons. Period of flow the same as for experiment 13, that is the filter has a rest daily from 5 P.M. to 7 A.M. Duration of experiment 12 weeks. The filter was mature before the start of the experiment. The septic liquor contained much suspended matter, and the surface of the filter clogged very rapidly: periodical raking was necessary. Towards the end of the experiment there was marked ponding, and the liquid on the surface of the filter stood at times over the level of the distributing channels.

TABLE 38.—Average composition of filter effluents.

—	—	Variation.	No. of analyses.
Ammon. N.	1·12	(0·52 to 1·74) ...	12
Album. N.	0·199	(0·096 to 0·34) ...	12
O abs. in 4 hours.	1·64	(1·01 to 2·45) ...	12
„ „ (clarified)	1·12	(0·72 to 1·37) ...	12
„ „ 3 mins.	0·833	(0·47 to 1·11) ...	10
„ „ „ (incubated)	0·802	(0·54 to 1·04) ...	10
Suspended solids	3	(2 to 5) ...	5
„ „	2	(1 to 4) ...	5
Incubator test smell	All passed	...	10
„ „ Stoddart	All negative.	...	10
Nitric N.	1·36	(0·9 to 2·5) ...	44
Units of purification	9,694	...	...

The effluents had a slightly opalescent appearance, and had an earthy smell. Incubation was for 7 days at 37° C.: in no instance was any smell evident after incubation, nor did a lead acetate paper reveal the presence of sulphuretted hydrogen. The life of the filter was poor, but the effluents produced were satisfactory.

Experiment 34.—Septic liquor same as for experiment 33. Same filter used in continuation of previous experiment, but the upper 12" of material removed, washed and replaced. Depth of filtering material 6′: rate of filtration—88 gallons per cube yard of material: one cube yard of the filter deals with the excrement of 6·6 persons. Duration of experiment 6 weeks: towards the end of the 4th week the surface layers again shewed marked sign of clogging.

TABLE 39.—Average composition of filter effluents, as compared with that for experiment 33.

Number of analyses 5.	Experiment 33.	Experiment 34.	—
Ammon. N.	1·12	0·52	54 per cent. decrease.
Album. N.	0·199	0·096	50 „ „
O abs. in 4 hours	1·64	1·05	36 „ „
„ „ (clarified)	1·05	0·91	13 „ „
„ „ 3 mins.	0·88	0·59	29 „ „
„ „ „ (incubated)	0·802	0·63	...
Suspended Solids	3	4	...
„ „ volatile	2	2	...
Incubator test smell	All passed ...	...	...
„ „ Stoddart	All negative	...	...
Nitric N.	1·36	1·91	40 per cent. increase.
Units of purification	9,037	...	...

The samples were clear liquids with an earthy smell. They resisted incubation at 37° C for 7 days.

Conclusions from experiment 33 and 34.—

1. A septic liquor with a calculated strength of 103·2 cannot be treated on a percolating filter at the rates of 88 and 100 gallons per cube yard daily, without causing rapid clogging.
2. It is uncertain whether the improvement in the effluent in experiment 34 is due to the reduction in the volume of liquor per cube yard of material, or to the addition of 1′ to the depth of material.
3. The septic liquor contained much suspended matter—24 parts per 100,000 during experiment 34—so the filter was soon clogged. The rate of filtration for a liquor of this nature should probably not exceed 25 to 50 gallons per cube yard of filter; a most extravagant rate except for very small installations, and consequently—
4. "Colloiders" placed in a septic tank dealing with a 15 gallon sewage do not produce an effluent which can be treated economically on a percolating filter.

Experiment 35.—Septic liquor from experiment 14. Strength of sewage 15 gallons: septic liquor passed through a macerating tank: "strength" of macerating liquor—83·02 rate of filtration 140 gallons per cube yard of material: one cube yard of filter for the excrement of 10 persons. Depth of material 4′ 6″ duration of experiment 10 weeks: filter well matured before start of experiment: at the close of the experiment there was no sign of clogging.

TABLE 40.—Average composition of filter effluents.

—	—	Variation.	No. of analyses.
Ammon. N.	1·87	(1·23 to 2·35) ...	10
Album. N.	0·181	(0·09 to 0·23) ...	10
O abs. in 4 hours	1·85	(1·45 to 2·61) ...	10
" " " (clarified)	1·45	(1·14 to 1·75) ...	10
" " 3 mins.	1·45	(1·14 to 1·75) ...	10
" " " (incubated)	1·14	(0·75 to 1·31) ...	10
Suspended solids Total	3	(2 to 4) ...	3
" " Volatile	2	...	2
Incubation test smell	All passed ...	...	10
" " Stoddart	All negative	...	10
Nitric N.	1·37	(1·0 to 2·0) ...	45
Units of purification	10,362	...	...

The effluents varied from clear fluids to slight opalescence; all had a faint earthy smell at the time of sampling: none developed any smell after incubation at 37° C. for 7 days, and in no instance was there any blackening of a lead acetate paper. This experiment took place at the same time as experiment 33: it was most instructive to watch the condition of the surfaces of the filters; in experiment 33 the surface layers of material were hidden by suspended matter, while in this

experiment there was no visible sign of suspended matter in the interstices of the material.

Experiment 36.—Followed directly after experiment 35, the same filter was used, and no period of rest was given. The rate of filtration was reduced to 110 gallons per cube yard: one cube yard of material for the excrement of 8 persons. Depth of filtering material 5′ 6″: duration of experiment 6 weeks.

TABLE 41.—Average composition of the effluents, in comparison with those for experiment 35.

—	Experiment 35.	Experiment 36.	—
Ammon. N.	1·87	0·91	52 per cent. decrease.
Album. N.	0·181	0·141	22 " "
O abs. in 4 hours	1·85	1·45	22 " "
" " (clarified)	1·15	0·96	16 " "
" " 3 mins.	1·45	0·811	44 " "
" " (incubated)... ...	1·14	0·614	......
Incubater test smell	All passed ...	...	......
" " Stoddart	All negative ...	...	... ..
Nitric N.	1·37	1·55	13 per cent. increase.
Units of purification	8,618	...	......

The effluents were slightly opalescent, had a faint earthy smell and withstood incubation at 37° C. for 7 days.

Conclusions from experiments 35 and 36.—

1. A percolating filter will deal with the septic liquor from 15 gallons sewage at the rate of 140 gallons per cube yard of material, if the suspended matter in the septic liquor is removed by passage through a macerating tank.

2. The use of a macerating tank prolongs the life of a filter, and consequently reduces the supervision required.

3. The maximum rate of filtration has not been ascertained at present.

Filtration of septic liquors obtained from sewages of 10 gallon dilution.—These liquors are of great "strength," and may contain 30 parts of suspended solids: on medium sized material the rate of filtration of such a liquor could not exceed 25 gallons per cube yard: even on coarse material of 3″ diameter and over a rate of over 50 gallons per cube yard could not be maintained without removal or flushing of the material. It is obvious that such rates of filtration would not prove economical. The succeeding experiments were carried out to show if it is possible to increase the rate of filtration of a strong septic liquor without damage to the filter.

Experiment 37.—Septic liquor from experiment 23. Dilution of the sewage 10 gallons: septic liquor passed through a macerating tank: strength of macerating tank liquor—106·46—strength of corresponding septic liquor 132·49—: rate of filtration 75 gallons per cube yard: one cube yard of material to 7·5 persons: depth of filtering material 7′: duration of experiment 5 weeks, at the end the rate of flow was increased. The filter was mature before the start of the experiment.

TABLE 42.—Average composition of the filter effluents.

Ammon. N.	1·136	4
Album. N.	0·25	4
O abs. in 4 hours	1·24	4
„ „ (clarified)	0·81	4
„ „ 3 mins.	0·629	4
„ „ (incubated)	0·83	4
Suspended solids Total	3	4
Suspended solids Volatile	2	4
Incubation test smell	All passed ...	4
„ „ Stoddart	All negative ...	4
Nitric N.	1·8	17
Units of purification	7,540	...

The effluent was a clear bright fluid with a faint earthy smell; it resisted incubation at 37° C. for 7 days. There was no trace of suspended solids in the interstices of the material.

Experiment 38.—Conditions as for experiment 37: rate of filtration—90 gallons per cube yard: one cube yard of material for 9 persons: depth of filter 6 feet. Duration of experiment 5 weeks: experiment in continuation of experiment 37, without a period of rest for the filter.

TABLE 43.—Average composition of the filter effluents.

Ammon. N.	2·11	4
Album. N.	0·25	4
Organic. N.	0·53	3
O abs. in 4 hours	1·6	4
„ „ (clarified)	0·81	4
„ 3 mins.	1·05	4
„ „ (incubated)	0·93	4
Incubator test smell	All passed ...	4
„ „ Stoddart	All negative ...	4
Nitric N.	1·5	20
Units of purification	8,388	...

The effluents were clear bright fluids, with a faint earthy smell: all resisted incubation at 37° C. for 7 days. The filter showed no sign of clogging.

Experiment 39.—Macerating tank liquor from experiment 25.—Strength of macerating tank liquor 100·21 per cent.—: strength of corresponding septic liquor—160·6—: dilution of sewage 10 gallons: rate of filtration 125 gallons per cube yard: one cube yard of material to 12 persons: depth of filter 5′: duration of experiment 15 weeks.

TABLE 44.—Average composition of the filter effluents.

—	—	Variation.	—
Ammon. N.	1·9	(1·52 to 2·53)	12
Album. N.	0·25	(0·16 to 0·46)	12
Organic N.	0·6	...	2
Oabs. in 4 hours	2·18	(1·76 to 3·05)	12
„ „ (clarified)	1·48	(1·11 to 1·93)	12
„ „ 3 mins.	0·93	(0·51 to 1·68)	12
Suspended solids Total	5	(3 to 7)	3
Suspended solids Volatile	4	(3 to 5)	3
Incubator test smell	Two failed.	......	12
„ „ Stoddart	All negative.	......	12
Nitric N.	1·37	(0·9 to 2·25)	47
Units of purification	10,400	... ..	...

The samples when taken were slightly opalescent: in two the smell was faintly ammoniacal, in the remainder earthy: two samples failed to withstand incubation at 37° C. for 7 days.

Experiment 40.—Strength of liquor same as for experiment 39: rate of flow 100 gallons per cube yard: one cube yard of material to 10 persons: depth of filter 6′: duration of experiment 5 weeks: filter worked in direct continuation of experiment 39 without any period of rest.

TABLE 45.—Average composition of filter effluents.

—	—	—	—
Ammon. N.	1·64	(1·36 to 1·81)	5
Album. N.	0·23	(0·14 to 0·38)	5
O abs. in 4 hours	1·62	(1·55 to 1·74)	5
„ „ (clarified)	1·47	(1·23 to 1·65)	5
„ „ 3 mins.	0·85	(0·71 to 1·07)	5
„ „ (incubated)	0·65	(0·49 to 0·80)	5
Incubator test smell	All passed	......	5
„ „ Stoddart	All negative	......	5
Nitric N.	1·4	(0·9 to 1·8)	19
Units of purification	8,678	......	...

The samples when taken had a faint opalescent appearance, and a slight earthy smell: all resisted incubation at 37° C. for 7 days. Towards the close of the experiment there was a deposit of suspended matter on the surface of the filter, but there was no tendency to ponding. The material from this filter and from the filter used for experiments 33 and 34 was removed; it had weathered very badly, the interstices were blocked by small fragments of unburnt brick: this probably led to the deficient aeration of the effluents as evidenced by the figures for nitric nitrogen; again deficient aeration favours weathering; these filters were constructed with solid masonry walls, which did not permit of side aeration.

Conclusions from experiments 37 to 40.—

1. A septic liquor from a sewage of 10 gallon dilution will rapidly clog a percolating filter unless the rate of filtration is very slow.
2. If the suspended matters are partially removed by passage of the liquor through a macerating tank the rate of filtration can be increased up to 100 gallons per cube yard, and probably still higher if the conditions for aeration are as perfect as possible.
3. Side aeration is probably advantageous in the case of a filter destined to deal with a liquor containing visible suspended matter; the main current of air is from above downwards, and is caused by the falling drops of effluent sucking in air after them. When the interstices of the surface layers of material are filled by suspended matter this action of the effluent must be interfered with.

Filtration of septic liquors obtained from sewages of 20 gallon dilution.—From table 21 it is clear that the suspended solids in the septic liquor may average 15 parts per 100,000. The Royal Commissioners have shown that a liquor containing this degree of suspended matter may be treated on a filter of medium sized material at a rate of 50 gallons per cube yard. Certain experiments with rates of flow up to 100 gallons per cube yard have been carried out, with the object of ascertaining if the rate of filtration laid down by the Royal Commissioners can be exceeded in India. It is unnecessary to detail them all, that dealing with a rate of flow of 100 gallons is described.

Experiment 41.—Strength of liquor from septic tank—79—: rate of filtration 100 gallons per cube yard: depth of filter 5′ 6″: surface area of filter 3·3 square yards: the filter was mature before the start of the experiment.

TABLE 46.—Average composition of filter effluent.

——	——	Variation.	——
Ammon. N.	0·39	(0·28 to 0·49)	5
Album. N.	0·19	(0·06 to 0·35)	5
O. abs. in 4 hours.	1·34	(1·26 to 1·41)	5
„ „ 3 mins.	0·73	(0·67 to 0·77)	5
„ „ „ (incubated)	0·61	(0·46 to 0·76)	5
Incubation test smell	All passed	......	5
„ „ Stoddart	All negative	......	5
Nitric N.	1·69	(·11 to 2·2)	19
Units of purification	7,640	......	...

The effluents were clear bright fluids, with no visible suspended matter as a rule; in a few samples there were pieces of brick. It is evident from the table that the filter was working well: it was noticed, however, that suspended matter

was accumulating in the interstices of the surface layers of material, although the filter had been working for only 12 weeks: it may be concluded that a septic liquor of this strength, containing 10 to 15 parts per 100,000 of suspended matter, can be filtered at or about the rate laid down by the Royal Commissioners. It was decided to try the effect on the rate of filtration of removing a portion of the suspended matter: the following experiments were carried out with this object on the same filter.

Experiment 42.—Septic liquor passed through a macerating tank (*vide* experiment 20): strength of macerating tank liquor—64—the suspended solids reduced to 4 parts per 100,000: the rate of filtration 140 gallons per cube yard: one cube yard of material for the excrement of 7 persons: depth of material in filter 5′ 6″. Duration of experiment 7 weeks.

The effluents were clear fluids, but in many there was evident suspended matter: all resisted incubation at 37° C. for 7 days: at the time of sampling the smell was faintly earthy. By the end of the experiment the suspended matter, which had collected in the interstices of the surface layers of material during experiment 41, had disappeared: it is possible that some was washed away with the effluent, thus accounting for the high figure for suspended solids as compared with the preceding and following experiments.

TABLE 47.—Average composition of filter effluents.—

——	——	Variation.	——
Ammon N.	0·82	(0·6 to 0·96)	7
Album. N.	0·12	(0 08 to 0·17)	7
O. abs. in 4 hours	1·05	(0·72 to 1·25)	7
„ „ (clarified)	0·79	(0·7 to 0·96)	7
„ „ 3 mins.	0·81	(0·35 to 1·17)	7
„ „ „ (clarified)	0·58	(0·41 to 0·8)	7
Suspended solids Total	7	(5 to 9)	2
„ „ Volatile	4	(3 to 5)	2
Incubator test smell	All passed ...	......	7
„ „ Stoddart	All negative	......	7
Nitric N.	1·58	(1·3 to 2·0)	21
Units of purification	7,840	......	...

These figures are satisfactory: there was no tendency to the accumulation of suspended matter, in spite of the fact that there was definite evidence of clogging at the close of the previous experiment.

Experiment 43.—Same strength of macerating tank liquor: rate of filtration increased to 180 gallons per cube yard: depth of filter 5′ 6″: one cube yard of material to 9 persons: the effluent samples were at times slightly opalescent, but rarely contained any visible suspended matter; at the time of sampling the effluents had a faint earthy smell, they all resisted incubation for 7 days at 37° C: a table giving the average composition of the effluents is not given, for, with the exception of the figures for suspended solids and nitric nitrogen it is identical with table 47. The figure for nitric nitrogen fell to 1·38—variation 1·0 to 1·8 for 18 analyses. Units of purification—10,000—the rise being due to the increased rate of filtration.

Experiment 44.—Rate of filtration increased to 220 gallons per cube yard: one cube yard of material to 11 persons: depth of material in filter 4′ 6″: duration of experiment 12 weeks.

TABLE 48.—Average composition of effluents.

—	—	Variation.	—
Ammon. N.	1·04	(0·92 to 1·13)	12
Album. N.	0·11	(0·06 to 0·22)	12
O abs. in 4 hours	1·52	(1·1 to 2·8)	12
" " (clarified)	0·81	(0·68 to 1·07)	12
" " 3 mins.	0·804	(0·52 to 1·14)	12
" " " (clarified)	0·93	(0·58 to 1·31)	12
Suspended solids Total	2	......	2
" " Volatile	2	......	2
Incubator test smell	All passed ...	......	12
" " Stoddart	All negative	......	12
Nitric N.	1·25	(0·9 to 2·2)	36
Units of purification	12,540	......	...

There was no evidence of clogging of the material at the end of the experiment; many of the effluents had an opalescent appearance, all had a faint earthy smell; all resisted incubation at 37° C. for 7 days.

Conclusion from experiment 42 to 44. That by the removal of a portion of the suspended matters it is possible to increase the rate of filtration for a septic liquor dealing with a sewage of 20 gallon dilution by about 4-fold.

The results of treatment of septic liquors on percolating filters are given in table 49. The experiments are incomplete, but one point is very prominent—the effect of suspended matter in the liquor on the rate of filtration.

TABLE No. 49.—*Table of Results for Percolating Filters.*

Experiment No.	Dilution of sewage.	Strength of septic liquor.	Suspended solids in septic liquor.	Strength of macerating tank liquor.	Suspended solids in macerating tank liquor.	Depth of filtering material.	Rate of filtration in gallons per cube yards.	Units of purification.	Remarks.
33	15	103	24	...	...	5′	100	9,694	Filter clogged rapidly.
34	15	103	24	...	...	6′	88	9,037	Ditto.
35	15	...	...	83	6	4′ 6″	140	10,362	No clogging.
36	15	...	...	83	6	5′ 6″	110	8,618	Ditto.
37	10	133	18	106	8	7′	75	7,540	Ditto.
38	10	133	18	106	8	6′	90	8,388	Ditto.
39	10	160	30	100	7	5′	125	10,400	Slight clogging.
40	10	160	30	100	7	6′	100	8,678	Ditto.
41	20	79	15	...	...	5′ 6″	100	7,640	Ditto.
42	20	79	15	64	4	5′ 6″	140	7,840	No clogging.
43	20	79	15	64	4	5′ 6″	180	10,000	Ditto.
44	20	79	15	64	4	4′ 6″	220	12,540	Ditto.

METHODS OF ANALYSIS.

Ammoniacal and Albuminoid Nitrogen.—The distillation process as described on pages 11 to 14 of Volume 4, Part 5 of the Report of the Royal Commissioners on sewage disposal.

Organic Nitrogen.—The modified Kjeldahl method described on page 138, 5th edition of Public Health Laboratory Work by Kenwood.

Oxygen absorbed from acid permanganate.—As described in chapter 2 of Sewage Works Analysis by Dr. G. Fowler.

Clarification test.—Described in the Journal of Chemical Industries for March 16, 1908, by Fowler, Sam Evans, and A. C. Oddie. The authors have pointed out that in the clarification process the sulphides are destroyed, consequently if sulphides are present in the septic liquor their destruction will add to the figure for fine suspended solids or "colloids." This fact must be remembered in interpreting the results of the test.

Incubator test.—As described by F. Wallis Stoddart in the Analyst for November 1901.

Nitric Nitrogen.—The phenol-sulphonic acid method described on page 99 of Kenwood 's book on public health laboratory work. The objection to the process is the irregular influence of chlorides; it has been stated that in the presence of chlorides the figure obtained may represent but 30 per cent. of the actual quantity of nitrates present : the water used for mixing the sewage contained a very high degree of chlorides; it was not possible to remove the chlorides before making the estimations, so, in considering the figures for nitric nitrogen the presence of chlorides must be remembered.

Suspended solids—Total and Volatile.—The Gooch process as described in the Journal of Infective Diseases for February 1906.

Distilled water.—Glass retorts and condensers used.

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ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

NOTE ON THE COLOMBO DRAINAGE SCHEME AND SEWAGE TREATMENT WORKS.

BY

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(1) The complete scheme as at present designed provides for the drainage of 4,764 habitable acres with a future estimated population of 251,000. Sewers are now available for an area of 1,700 acres and an estimated future population of 125,000. Owing to recent extensions of the City and the abnormal increase in the population, the scheme is likely to be revised and modified by the provision of a second outfall and treatment works.

(2) Drainage is on the separate system, but in some cases the smaller sewers receive both rainwater and sewage; any excess over six times the dry weather flow being diverted to the rainwater sewers at separator chambers.

(3) The sewage is lifted at district pumping stations and at the main pumping station at the Treatment Works by centrifugal pumps worked with Gas Engines supplied from Suction Gas Producer plants using Anthracite Coal.

(4) The present instalment of the Treatment Works is designed to deal with the sewage from a population of 60,000 and consists of four interchangeable units of rectangular detritus and septic tanks, 2 units of stormwater settling tanks and roughing filters, and eight aerobic beds. The dry weather pumps are designed to deliver twice the dry weather flow to the Septic Tanks and the Storm pumps four times the dry weather flow to the storm units. Each detritus tank is 27 feet long and each septic tank 240 feet long. The tanks are 9 feet deep and 14 feet wide.

The bottoms of the detritus and septic tanks slope slightly to the central sludge channels which have a fall of 1 in 240 to the sludge outlets. The aggregate capacity of the septic tanks is equal to 12 hours mean dry weather flow. The tanks were originally covered with light galvanized iron roofs.

(5) The eight aerobic beds are each 97′·6″ effective diameter and 7 feet deep. The tank effluent is distributed by revolving sprinklers supplying at the rate of 220 gallons per square yard per diem with a mean dry weather flow of 25 gallons per head.

The media in the beds is gneiss road stone broken by crusher, the top 9 inches, fine material; the middle portion 1½ inches, and the bottom 2 feet layer 3 inches stone, supported on drainage tiles over the concrete floors.

Before entering the outfall channel, the effluent from the beds passes through small detritus pits and gauge chambers.

(6) The two stormwater settling tanks are each 85′ 0″ × 55′ 0″ × 7 feet deep, and the attached roughing filter 108′ 0″ × 85′ 0″ × 7 feet deep. The final effluent is discharged into the Kelani river 7 feet below mean sea level and 1½ miles from the coast.

(7) It is intended to enforce the water carriage system of house drainage throughout the whole of the sewered areas. The only material modification from accepted Western practice will be the use of native pattern water closets and separator gullies for receiving the foul sullage flow from the open channels and paved yards in the poorer premises.

(8) The first house connection to the new sewers was made in November 1910, and at the time of writing (October 1912) there are 277 connections serving 349 premises and 11 public latrine and bathing places: 438 European pattern and 445 native pattern water closets, 178 public latrine seats and 80 public bathing stalls are now in use.

(9) To obviate night work and economize pumping charges, the pumps at the main pumping station are used during the day only so that the flow through the

tanks and beds is not continuous, and working conditions are not yet normal. The average daily flow delivered through the plant is about 1,500,000 gallons of which 900,000 gallons are passed through two septic tank units and the aerobic beds and 600,000 gallons through the storm units.

It is estimated that this flow represents the sewage derived from premises with a population equivalent to 6,000 and from public latrines used daily by 30,000 people, together with sub-soil and other water entering the sewers through leakage and from other temporarily unavoidable sources.

(10) The subjoined analyses of the sewage and effluents indicate the character of, and change in, the sewage dealt with :—

Analysis No. 1.

Date—November 7th, 1911.

Method. Hourly samples bulked.

Septic Tank units in use. Nos. 1 and 2.

Storm Tanks units in use. No. 1.

Daily flow through Septic Tanks. 637,500 gallons.

" " " Storm Tanks 1,250,000 "

Total Flow. 1,887,500 "

Weather. Heavy storms and previous continued rain.

Sub-soil Water Level. High.

Lake Level. High.

Parts per 100,000.

Samples from :—	Inlet to Detritus Tanks.	Effluent from Septic Tanks.	Effluent from Aerobic Beds.
1. Total Solids and Suspended matter	60	64	60
2. Total organic matter	14	10	10
3. Total mineral matter	46	54	50
4. Total solids in solution	58	64	60
5. Organic matter "	6	8	4
6. Mineral matter "	52	56	56
7. Chlorine	14	17	13
8. Free Ammonia	0·240	0·280	*Nil*
9. Albuminoid Ammonia	0·105	0·048	0·013
10. Oxygen consumed in 2 hours	0·585	0·64	0·16
11. Nitrites	0·19	0·17	0·07
12. Nitrates	1·6	1·2	1·6

NOTE.—The sewers were receiving the drainage of about 70 premises and one large public latrine and bathing place estimated to be equivalent to the flow from a population of about 7,500. The volume dealt with was over 1,000,000 gallons in excess of the previous dry weather flow. The extraordinary excess being due to the abnormal wet weather, the high level of the sub-soil water and the entrance into the sewers of lake water through temporarily open outfalls.

The high chlorine figure for the very dilute sewage is explained by the presence of chlorine varying from 8·0 to 19·0 parts per 100,000 in the sub-soil and lake water.

Analysis No. 2.

Date. September 30th, 1912.

Method. Hourly samples bulked.

Septic Tank units in use. Nos. 3 and 4.

Storm units in use. No. 2.

Daily flow through Septic Tanks.—900,000 gallons.

" " " Storm Tanks.— 432,000 "

Total flow ... 1,332,000 "

Weather.—Rain and previous wet.

Sub-soil Water.—Low.

Lake Level.—Medium.

Parts per 100,000.

Sample from	Inlet to Detritus Tanks.	Effluent from Septic Tanks.	Effluent from Aerobic beds.
1. Total Solids and suspended matter	66	52	45
2. Total organic matter	18	12	5
3. Total mineral matter	48	40	40
4. Total solids in solution	50	41	40
5. Organic matter in solution	10	4	3
6. Mineral matter in solution	40	37	37
7. Suspended matter, total	16	11	5
8. Do. do. organic	8	8	2
9. Do. do. mineral	8	3	3
10. Chlorine	8·5	8·5	8·5
11. Free ammonia	2·1	2·1	0·49
12. Albuminoid ammonia	1.05	0·75	0·15
13 Oxygen consumed in 2 hours	2·07	1·67	0·75
14. Nitrites	*Nil*	*Nil*	much
15. Nitrates	*Nil*	*Nil*	2·4

Note.—The sewers were receiving the drainage of 349 premises estimated to be equivalent to the flow from a population of 6,000, and the drainage from 11 latrines and bathing places used daily by about 30,000 persons.

(11) With regard to the operation of the plant, it was early found that mosquitos bred in enormous numbers in the two septic tanks first put into use, and after spraying with kerosine had proved useless the roofs were removed. This had immediate and lasting effect. The roofs from the remaining septic tanks which have more recently been put into use have not been removed as there is no evidence of mosquitos. This is doubtless due to the increasing strength of the sewage and the presence of a thin film or scum on the surface of the liquid in the tanks.

(12) The aerobic beds have passed through many interesting phases. At some time or another the surface of all the beds has been covered with a dark green gelatinous growth of algæ of varying thickness and character. Temporary disuse of the bed changes the growth to a leathery adhesive skin, which can be in part raked off, and which ultimately distintegrates to a reddish brown humus.

This growth materially affected percolation and aeration and as an experiment the top few inches of the fine surface layer over a portion of one bed was replaced by 2 inches stone. The successful result of the experiment is attributed to the quicker percolation to layers unaffected by sunlight.

On the resumption of pumping every morning a considerable quantity of brown humus is washed through the beds with the effluent. An analysis of this material is given later.

(13) Twenty-one months elapsed before the tank unit first in use was desludged. In the case of the Detritus Tank the supernatant sewage is drawn off through the sludge valve and returned to the pump sump and the residual sludge dried on the tank bottom before removal to the dumping ground. In the case of the septic tanks the supernatant sewage is discharged to the pump sump through the decanting valves, the thick liquid sludge drained through the sludge valve to earthen sludge drying channels, and the remaining sludge drained and partially dried on the tank bottom before removal to the dumping ground.

(14) Three hundred and eighty cubic yards of wet sludge, average 80 per cent moisture, were removed from No. 1 Septic and Detritus Tanks after approximately 200 million gallons of dilute sewage had passed through the unit. The quantity is equivalent to 6·3 parts per 100,000 of dried suspended matter removed from the sewage by the tank process.

(15) The following analyses of sludge are from samples taken by sludge gauge whilst the tanks were in operation, but agree fairly well with analyses of sludge removed from the tanks.

(16) Column (C) is an analysis of the humus washed through the aerobic beds.

Analyses No. 3.

Date. (A) and (B) February 16th 1912. (C) February 26th 1912.
Method. (A) and (B) Chance Samples by sludge gauge.
(C) Chance Sample from No. 1 Aerobic Bed Channel.

—	(A) Detritus Tank No. 1.	(B) Septic Tank No. 1.	(C) Aerobic Bed No. 1.
Conditions:—	(Reddish mud)	(Dark mud)	(Reddish mud)
—	Alkaline, mud smell, containing pieces of wood, leaves and grit.	Alkaline, mud smell, containing pieces of wood, leaves and charcoal, the last predominating; when it was being heated at 110°F meaty smell given off.	Alkaline, mud smell (water running out of bottle when received).
Org: Sludge	694·0 Gms.	657·0 Gms.	654·0 Gms.
After drying	184·0 "	119·0 "	154·0 "
Moisture	510·0	538·0	500·0
Moisture	73·5 %	81·8 %	76·4 %

Grit not passing through 20 mesh sieve is :— Sludge not passing through 20 mesh sieve is :—

1·3 %		4·26%	
	Dried.	Dried.	Dried.
Moisture	2·400 %	2·400 %	2·00 %
Ash	76·200 "	60·200 "	82·400 "
Organic Matter	21·400 "	37·400 "	15·600 "
	100·000	100·000	100·000
Chlorine	0·730 %	0·730 %	0·730 %
Nitrogen	0·220 "	0·700 "	0·740 "
Equal to Ammonia	0·265 "	0·850 "	0·938 "
Lower Oxide of Iron ...	Much	Much	Much
Acidity.	Alkaline.	Alkaline.	Alkaline.

(17) Analyses have also been taken of the mud deposited on the surface and in the interstices of the surface layers of the beds and showed from 63 per cent to 84 per cent of mineral matter.

(18) The maximum standard type public latrine adopted in Colombo provides 12 seats for men and 6 for women, the minimum size 4 seats for men and 2 for women. Bathing places with 6 stalls for men and 3 for women are attached to all the larger latrines.

The native pattern pans are arranged in series of six and connect direct without a trap to a 6 inch stoneware pipe laid horizontally and immediately under the pan outlets. To prevent fouling and to facilitate flushing, water to the depth of 2 inches is retained in the bottom of the drain by a sloping weir at the outlet end. The 6 pans in each series are flushed from a 10 gallon automatic tank and the horizontal drains additionally flushed by the waste water from the bathing places, or when these are not provided, by 10 gallon automatic tanks.

A recent modification provides one 3 gallon automatic tank flushing 2 pans. The arrangement is not yet in use but it is expected to give a better flush with less water consumption and will also enable portions of the latrine to be shut off at night without interference with the flushing arrangements.

Each stall is provided with a spring push tap supplying water for ablution purposes. No doors are provided to the stalls, but the pans are arranged longitudinally and the entrance openings reduced to 16 inches, giving partial protection to the user.

The water for bathing purposes is supplied through shower pipes without roses and regulated by spring push taps fixed on the wall opposite the user.

The latrine buildings are constructed with cement and sand bricks with red quarry tile flooring and white glazed wall tiling in the latrine stalls. With the exception of the light reinforced concrete slab roofing over the latrine stalls the buildings are unroofed.

A recent count shows that the maximum type latrine provides accommodation for 3,000 users per diem.

(19) As experimental work has not yet been undertaken, a definite opinion cannot be given, but the Author makes the following tentative suggestions with regard to the design of Septic Tanks and Aerobic Installations in the Tropics.

The Septic Tanks may be of much less capacity that is usual in Western practice, as septic action is much more rapid under tropical temperatures and advanced septicization is not essential or desirable.

Provision should be made for the withdrawal of the lower and more digested sludge without interference with the operation of the tank. In the design of the tank consideration should be given to securing efficient retention of solids in suspension. This is especially necessary owing to the disturbance of the supernatant sewage by the violent and constant ebullition caused by rapid septic action.

For practical purposes an aerobic bed media of one grade and comparatively large size, may present advantages over finer material. With the same cubic capacity the latter will admittedly give a better effluent when in proper working order, but surface ponding which is difficult to prevent and expensive to remedy, will materially affect percolation and aeration to the detriment of the effluent.

A bed composed of larger material is self-cleansing, efficient aeration which is essential to the process is obtained, and there is less smell. Combined with proper distribution and settlement and removal of the suspended solids in the tank effluent, sufficient purification may be obtained for all practical purposes.

If finer grade material is adopted, the surface should be covered with a shallow layer of larger stone. This will delay ultimate clogging of the bed by preventing or reducing surface growths.

The sludge from septic tanks even when not fully digested is inodorous and can be drained and dried by natural means without difficulty. Intestinal organisms survive in diminishing amount, but from a pathological standpoint it cannot be considered that the sludge is innocuous and it should be tipped as far as practicable from human habitations.

Night-soil disposal and associated fly breeding.

The question of the best method of the disposal of night-soil without fly breeding, in towns which have no water borne sewage system and which are endeavouring to obtain some return for the expenses incurred in the conservancy staff and plant, is one which teems with difficulties. The various methods employed are as follows :—

I. By separate septic tank installations for each latrine.
II. By incinerators.
III. The Thornhill system.
IV. The shallow trenching system.
V. The pitting system.
VI. The 2-foot deep trenching system.
VII. The method in small villages of deposition of excreta in the neighbouring fields.
VIII. The absorption or filter trench system with removal of excreta to trenches.
IX. And in addition the methods in vogue at fairs :—
- *(a)* The shallow pan system with removal of the solids to trenches.
- *(b)* Defœcation in open courtyard without pans but with a removal of the solids to trenches.
- *(c)* In firm soil the shallow 9 inches wide, 1 foot 6 inches deep trench, into which defœcation is direct.
- *(d)* In sandy loose soil the deep trench into which the dejecta fall direct, but in which boards with supporting cross beams are placed to protect the edges of the trench from falling in by the weight of the user.

I. In the first system the installation is easy to work but the initial expense is large and the effluent is unfit to run into small streams and should be treated on land.

II. In incinerators we have an excellent method of disposal in towns or parts of towns where horse litter is obtainable or where the rubbish is of an inflammable character. The objections to the general use of incinerators are:—
- *(a)* That the rubbish in civil stations is usually of such a character that it will not burn well.
- *(b)* That it is usually damp and in the rains very wet and requires long storage.
- *(c)* That constant supervision is required.
- *(d)* That no income accrues to the municipality from the sale of rubbish and night-soil although the expenses of cartage are diminished.
- *(e)* The objection especially in Burma to the smell of incinerators.

III. The Thornhill system is the best method of earth disposal and does not lead to the breeding of flies provided supervision is constant. The difficulties experienced with it are :—

(1) The necessity for constant supervision without which pulverization is not well carried out.

(2) Too many carts are placed in one trench.

(3) The position of the land chosen must be such that irrigation is possible.

(4) The expense of digging the trenches is large.

The following is the comparison of the Thornhill and the 2-foot trench system as carried out at Allahabad :—

	Municipality.	Cantonment.
(1) Cubic feet dug per man per diem	132·7 no pulverization	80 and with pulverization.
(2) Trenches per man ...	2 9 ($10\frac{1}{2} \times 3\frac{1}{2} \times 1\frac{1}{2}$)	1 ($16 \times 5 \times 1$)
(3) *Beldars* per 1,000 population	1 per 4,320 population	2 per 1,000.

that is to say where 19 *beldars* are now used for 80 carts, 80 *beldars* would have to be employed if the Thornhill system were adopted.

IV. The pitting system is carried out in several ways. The most successful is by carrying the night-soil to pits in the fields of cultivators outside municipal limits.

Another pitting method that is used is to fill up large 6 feet deep pits with solid night-soil which is removed from the private latrines of the towns. When these pits are opened the stench is unbearable and fly larvae abound.

V. The shallow trenching system is carried out by placing the night-soil in trenches 9 inches deep and about 9 inches wide.

VI. The revised instructions for the guidance of municipal boards in the United Provinces on the disposal of night-soil are as follows :—

"(1) A common method of disposal of night-soil in municipalities is by trenching in suitable trenches, and subsequently disposing of it to cultivators after it has remained a sufficient length of time in the ground. Trenches should be 2 feet broad and not more than 2 feet deep. A depth of 18 inches would be better, but economy generally demands the greater depth which should however never be exceeded. These trenches should be dug in straight parallel lines 2 feet apart from one another. Night-soil to the depth of one foot should be placed in them and the trenches then filled in with all earth taken out. They should, therefore, present the appearance of lines of mounds, the elevations indicating the site of the trenches. The earth will in a few months subside to the general ground level. Filth thus trenched will usually be resolved into harmless products after some six months' burial, but inasmuch as the rapidity with which such changes are effected depends largely upon the character of the soil, it is desirable in every case to ascertain, by an experimental excavation, whether the contents of a trench are dry and inodorous before the same are sold to cultivators and others.

The length of a trench or trenches occupied by the night-soil of each month should be marked with a small post with the number of the month and the year painted on it. Thus January 1908 would be 1/1908, and so on. Separate trenches should not be used for each month, but a post put in on the first day of each month at the point filled in on the previous day.

The land taken up for trenching should be loamy or alluvial. Sandy soil should not be used for the purpose. A site once trenched should not be used for more than one year or at the outside two years. After this time there will be no earth left to fill up the trenches over the night-soil deposited in them. The side should then be levelled and a few crops taken off it, when it can again be trenched. Urine is also best disposed of by trenching in a similar way.

(2) A second method is to trench as already described, and then take a succession of exhausting crops off the land, such as vegetables tobacco, &c. Land thus treated can be trenched every year if the cultivation be complete and constant. The method, however, is not one which municipalities are likely to adopt.

(3) A third system ("pitting"), practised at Lucknow and a few other places, is to sell the night-soil direct to cultivators under certain restrictions. The procedure adopted at Lucknow is as follows :—When a cultivator desires to purchase the night-soil he applies to the municipal authorities. Before his request is granted the locality in which it is proposed to utilize the manure is visited by the assistant health officer or the conservancy inspector, who reports whether the situation is suitable. If this be the case the night-soil is removed by the municipality to the spot and there deposited in pits, 2 to 3 feet deep and 5 to 12 feet wide. The pits are dug by the cultivators, and are inspected by the conservancy jamadar when completed. The manure remains "pitted" about three months and is then spread in the fields and ploughed in. The dry earth system being in force the night-soil reaches the pits already mixed with a considerable quantity of dry earth.

The system followed at Farrukhabad and Shahjahanpur is practically the same as at Lucknow. The difference is that in Farrukhabad the stuff is bought from the private sweepers who carry it on their own animals to the pits which are dug by cultivators and inspected by the secretary before being brought into use. The sweepers are supplied with form books containing details as to the number of loads, &c., which are filled in and signed by the *muharrir* on the spot. There are also other forms in the possession of the *muharrir* which have also to be filled in and according to the entries made in them the demand from the cultivator is fixed and the sweepers are paid. The rate charged is generally 5 *paisas* or one anna 3 pies per load—a load being taken at 5 cubic feet. The price is not always the same, and it varies according to the distance to which the night-soil has to be carried and the demand for the stuff at the time. The amount paid to sweepers is one pice or 3 pies less than what is realized from the cultivators. The municipality thus gains three pies on each load supplied. In Shahjahanpur the sweepers claim a hereditary right to all the stuff which they collect from private latrines. The municipality therefore has the right only to night-soil from public latrines. This is auctioned annually in convenient lots to the sweepers, and the municipality again purchases this and that also from private latrines and sells it to cultivators. In this municipality application for night-soil has to be made by cultivators at certain seasons of the year when the demand is greater. The sweepers carry the stuff to the pits dug by the

cultivators in their fields where the forms in the possession of the sweepers and *muharrirs* are filled in by the *muharrir*, and payments and demands are calculated according to the entries made in these forms at the end of each month. The price is calculated per 100 donkey loads, each load measuring 1½ cubic feet. The price varies from Re. 1-12-0 to Rs. 5-8-0 and Rs. 2-4-0 to Rs. 7-0-0 according to the distance to which the stuff is to be carried. The night-soil is buried in pits of various sizes for periods varying from three months upwards.

(4) At Saharanpur the system is a complicated one. The night-soil from public latrines is removed by contractors of the sweeper caste and sold by them to cultivators at a rate fixed by the board and is trenched in the fields of the cultivators by the board's conservancy staff in trenches 1½ feet deep and 2 feet broad. The sums paid by the cultivators are paid direct to the municipal board. The board then repays the contractors the sums thus received less 10 annas per 100 bags (representing the price at which the board sells the stuff to the contractors) and deducting also 8 annas 4 pies per 100 bags as commission for the expenses incurred in trenching the night-soil and in general supervision. A similar system is adopted for private houses. This night-soil is by custom the property of the sweepers who are the private servants of the householders and are not paid by the board. These sweepers take the stuff to the fields of cultivators, where it is trenched by the board's conservancy staff. The cultivators pay at fixed rates to the municipal board who repay the sweepers individually, deducting 8 annas 4 pies per 100 bags commission as trenching charges. Outside municipal limits 8 annas as excess per half mile per 100 donkey loads are charged for carriage.

At Moradabad excreta from private latrines is taken by private sweepers to the municipal trenching grounds where they are paid by the load.

Night-soil removed as above is usually mixed with sweepings.

The above system are remunerative and mostly preferred by the cultivators. They obviously however depend for their safety upon the degree of supervision exercised and the judgement displayed in seeing that the pits are not too near habitations, wells and sources of water supply. Long-trenched night-soil has not the manurial value of pitted night-soil.

(5) The following instructions regarding "pitting" and "trenching" should be observed carefully:—

(a) No pits or trenches should be permitted within a minimum distance of three hundred yards of habitations, wells and other sources of water supply.

(b) Pits should not be more than 3 feet deep, and if possible a layer of earth should be placed over each cart-load of night-soil that is unmixed with sweepings. Each pit should be covered by a foot of earth. Cultivators prefer deep pits as then comparatively little change occurs in the night-soil.

(c) Pitting should be done by municipal employés who are under control, or if done by the cultivators should be under municipal supervision.

(d) Pitting and trenching may be carried on side by side at all times of the year.

(e) The period of pitting should not be less than four months, but in practice six months' time has been found better. This depends upon the nature of the soil. In light loamy or alluvial soils changes occur rapidly: in the clay more slowly. Night-soil if too long trenched loses its manurial value, but on the other hand it is probably dangerous if dug out before the expiry of the proper time. The changes that occur are aerobic and anaerobic—chiefly the latter.

(f) In some municipalities the muhalla sweepers claim a prescriptive right to the night-soil removed by them and realize a considerable income from the sale direct to cultivators and others. No proper precautions for its deodorization, &c., being taken, the system is directly conducive to an insanitary state of affairs within and around the towns. Moreover it results in a loss of income to the municipalities concerned. The municipal boards can, if they so wish, bargain with the hereditary sweepers for the night-soil. If however it is sold direct and deposited within municipal limits strict supervision by municipal officials is necessary and should be exercised. As explained above, the municipalities of Farrukhabad, Shahjahanpur and Saharanpur buy all night-soil from private sweepers and do the trenching or pitting in the fields of cultivators, exercising control over the site and manner of disposal.

(g) Poudrette is required chiefly in September and October. For sugarcane it is required early in the year (January and February). There is a demand for fresh night-soil in the months of February and March when it is used on the sandy beds of rivers for melon beds, and when far removed from habitations there is no objection to its being so used.

(6) In some of the western districts the custom is to deposit all the filth in deep and large pits and then dig it up after a variable interval, often unchanged, and sell it to cultivators. The system is radically wrong and should be everywhere abandoned. Another even worse plan is to sell the fresh night-soil to cultivators, who pile it up in their fields and cover it over with a little dry earth until it is wanted. Again another bad system is to sell it mixed with rubbish for use in brick kilns. The night-soil accumulates in large quantities until the kiln is ready for firing, and breeds out flies, and inasmuch as these kilns are often near towns, the danger is obvious. The practice may, however, be tolerated in cases where the kiln is situated at least half a mile from the inhabited area but only when the cleanliness of the surrounding area is ensured, and the actual firing is likely to be quickly carried out.

There is no objection to the use of general street rubbish, however, for this purpose, but it should not be allowed to accumulate before firing as flies breed out. Rubbish is of a high manurial value and in Meerut a large income is derived from its use on the grass farm.

(7) In many municipalities where there is no sale, full advantage of valuable fertilizing material is not being taken. The first object of course is to dispose of all impurities in a sanitary manner so that the health of

the community may be maintained. The various methods of doing this have been described above. In many cases, however, there is no sale for the resulting manure and thus it becomes lost. It should be the endeavour of Chairmen to utilize this by taking up land where this is possible, and trenching on the shallow system and cropping with exhausting crops as potatoes and tobacco. This system was introduced by Colonel Thornhill at Bareilly and consists in digging trenches 16′ × 5′ × 1′ with 6 inches between each trench and 6 inches between each line of trenches. The soil removed is thoroughly pulverized—an essential point—and 2 inches is returned to the trench into which the contents of one or two night-soil carts are tipped. If the night-soil is mixed with earth the whole of the remaining earth need not be returned. A depth of 1 foot is necessary as otherwise flies breed out in large quantities. Land so trenched does not require manuring again usually till the fourth year. In every case where this method is practised provision for irrigation by wells (or otherwise) should be made. At Bareilly cantonment, land leased at Rs. 5 a bigha rents for Rs. 30 the first year after shallow trenching, and less in succeeding years. At Allahabad cantonment land after manuring rents for Rs. 50 a bigha. Speaking generally, if land is available, shallow trenching on the Thornhill system is probably the most valuable method of disposal of night-soil, but trenching and pitting are much in vogue in these provinces and are in many places remunerative and, from a sanitary point of view, unobjectionable if properly performed."

The method most in vogue in the United Provinces is disposal in trenches 2½ feet deep, 2 feet wide and 10 to 40 feet long.

Into these trenches night-soil to a depth of 1 foot should be placed and covered in with the 2 feet of soil removed. This is rarely carried out. The trenches are filled to the brim. If the night-soil is of fluid consistency branches of shrubs are placed on it and the soil replaced over the branches.

Usually the soil sinks through and the liquid night-soil bubbles up. The contents of these pits are sold at the end of six months and the pits refilled. This method is the cheapest but in the course of five years' experience both in India and Burma, the author has seen very few trenching grounds wherever this method was carried out in which fly larvae did not abound.

To give some idea of the enormous fly production consequent to these methods of disposal the following experiments were carried out.

His Honour Sir John Hewett complained that the flies at Government House, Allahabad, were very troublesome and asked for an explanation. A trenching ground was situated within half a mile of Government House the surface of which was a mass of newly hatched flies and the trenches a crawling mass of larvae.

The author was engaged in the sanitation of the *Magh Mela* and could not spend much time on the experiment.

The following procedure was adopted:—

One cubic foot of night-soil containing larvae in their pupa stage was removed in a sweeper's basket such as is used in every household for the removal of commode pans and was enclosed in a mulmul bag. A

second cubic foot containing larvae in their maggot stage was placed in two baskets, as the night-soil was in a semi-solid condition. From No. 1 basket 1,290 flies were obtained between January the 26th and February the 14th.

In basket No. 2 flies commenced to hatch out on February the 5th and 2,737 flies in all hatched out by the end of the month.

Neither experiment was wholly satisfactory for the following reasons :—

In No. 1 (*a*) On digging the soil the upper layers were placed lowest in the basket.

(*b*) From the fact that 368 flies were hatched out the day after removal from the trenches, and on comparison with the rate of hatching in experiment No. 2 we can deduce that probably many pupae from this cubic foot had become flies previous to their removal to my camp.

No. 2 was also not satisfactory for although the cubic foot was divided in two baskets and in each was placed a depth of soil of 6 to 8 inches the moisture rapidly evaporated owing to the exposure to air all round the baskets. Secondly, no increase of larvae could be obtained from the visits of gravid female flies to the baskets. In the trenches the night-soil was bubbling up above the soil and was visited by thousands of flies. It has also been noted that even in old night-soil in uncovered pits pupae in the upper layers, and maggots in the lower, can be found. The best method of conducting the experiment is undoubtedly by placing a meat safe over the actual trench, but even then the question of re-ovulation is not solved, and it is difficult to enforce the continual presence of a chaukidar to prevent the dish cover from being moved or stolen. Even in my experiment some person tore open the netting of No. 1 to see what the basket contained.

The area trenched from October the 28th to December the 31st, 1909, was 243 × 229 feet = 55,647 sq. feet.

50 × 243	feet	....	=	12,150 sq. feet.
119 × 286	„	....	=	34,034 „ „
	Total	....		101,831 sq. feet.

Each trench is supposed to be $10 \times 3 \times 1\frac{1}{2}$ foot, but by actual measurement was found to be $10\frac{1}{2} \times 3\frac{1}{2} \times 1$ foot. Between each trench a space of 6 inches was left.

$10\frac{3}{4} \times 3\frac{3}{4} = \frac{43}{4} \times \frac{15}{4} = \frac{645}{16} = \frac{101,831 \times 16}{645} = 2,526\frac{26}{645}$ trenches. But the area giving off flies is $10\frac{1}{2} \times 3\frac{1}{2} = \frac{21}{2} \times \frac{7}{2} = \frac{147}{4}$.

$\frac{645}{16} - \frac{147}{4} = \frac{645-588}{16} = \frac{57}{16} = 3\frac{9}{16}$

$\therefore 2,526 \times \frac{57}{16} = 8,999$ cubic feet.

Therefore the area giving off flies, i.e. 8,999 multiplied by 2,737 the number of flies counted equals 24,630,263, i.e. 24 million flies from an area of 2·3 acres.

The flies were sent for examination to Dr. Imm, Biologist at the Muir College, who stated that he considered they were Musca Walli and other species of the common house fly.

Turning now to the examination of the method of trenching, Dr. Sousa, Health Officer, Allahabad, stated that 75 to 80 carts reach this ground daily.

The ground was in use in—

October	....	....	4	days.
November	....	....	30	„
December	....	....	31	„

Total 65 days, which should give a total of $65 \times 80 = 5{,}200$ carts or $65 \times 75 = 4{,}875$ carts.

Each trench is worked out to take one cart only. We have calculated, vide above, that there are only 2,312 trenches showing that at least two carts are emptied into one trench.

In Meagher's book on farming on the Allahabad system of trenching it is stated expressly that for each Crowley cart a trench is required $16 \times 5 \times 1$ foot depth, of which 9 inches of soil are pulverized and replaced before the cart is emptied on the surface, and then 3 inches of pulverized soil are placed over the surface of the night-soil.

A horse galloped over the ground should not make an impression in the soil deeper than 2 inches.

In the Thornhill system the dimensions of the trench are the same, the difference only being that 9 inches are removed, 3 inches pulverized soil placed in the trench and 9 inches placed over the night-soil.

The present system is defective in that—

(1) $10 \times 2 \times 1$ trench is only sufficient for a 75 or 110 gallon cart but not for a 200-gallon cart. A trench $10 \times 3 \times 1$ would contain the contents of the larger type of cart.

(2) The whole contents of the trench is removed, no pulverizing is attempted, the dry hard base allows little percolation of the fluids, especially as they are in a colloid condition, the hard clods placed on the top falling through the semi-fluid contents.

(3) More than one cart is placed in each trench.

(4) A dog running over the surface sinks deeply in.

(5) As the clods sink the fluid faeces oozes up and the whole becomes an enormous breeding ground for flies. Further, the manurial value of the contents of these trenches must be very considerably reduced by the loss of organic matter in flies as well as by the loss of nitrates into the surrounding soil.

In the methods enumerated under No. 8 as carried out at fairs the same trouble is experienced. The trenching system in which the trenches are visited by the people themselves is the one recommended for the simple reason that in fairs, such as the *Magh Mela* at Allahabad extending over 6 weeks, there are certain days in which 15 lakhs of people may be present, and although all do not defoecate on the fair ground the attempt at the removal of the dejecta of large crowds of people is an impossibility without incurring enormous expense. The incineration of this material is equally impossible as the rubbish consists largely of broken potsherds which rapidly clog the interstices of the grates. After about

two weeks of a fair it is noticed that young flies begin to hatch out. When the trenches are in sand it is impossible to prevent this as the character of the soil renders the egress easy. When in ordinary soil the length of time that the trench has to be kept open during the intermediate days of the fairs in which the huts are scarcely occupied predisposes to fly-breeding, but even in trenches closed on the day of first use and hammered down with road mallets flies breed out and may tend to the dissemination of cholera.

The receipts and expenditure on conservancy in four selected cities will be seen from the attached table.

At Saharanpur (population 62,850) with a pitting system the sale proceeds of land and produce of land are Rs. 603 per annum and the conservancy receipts Rs. 5,462, while the expenditure on conservancy (including road cleaning and watering) and latrines is Rs. 30,735, of which Rs. 3,287 is expended on cost and feed of live stock, Rs. 2,975 on plant and contingencies and Rs. 20,823 on establishment.

At Meerut with a population of 76,351 the conservancy receipts amount to Rs. 11,852 and the expenditure Rs. 32,611, of which Rs. 4,437 were spent on plant and contingencies and Rs. 29,432 on establishment.

At Hapur (population 19,142) the conservancy receipts are Rs. 6,023 per annum and the expenditure Rs. 10,248, of which Rs. 1,350 were expended on plant and contingencies and Rs. 8,614 on establishment.

At Fatehgarh-cum-Farrukhabad (population 56,573) with a pitting system the income from conservancy is Rs. 18,328 and the expenditure Rs. 31,302 per annum of which Rs. 15,937 were expended on plant and contingencies, Rs. 1,203 on cost and feed of live stock and Rs. 13,182 on establishment.

The cost of establishment is thus the heaviest item and one which cannot be largely reduced without loss of efficiency.

In view of the difficulties of the disposal of night-soil as cheaply as possible and yet with the elimination of fly breeding the author has raised the following point for discussion :—

(A) What is the best method of night-soil disposal at fairs to prevent fly-breeding, taking into consideration the question of *(a)* expenses, *(b)* fluctuating population which may reach 2 millions in a day?

(B) What is the best method of excreta disposal in towns to prevent fly-breeding in *(a)* night-soil in a colloid condition and *(b)* in a solid condition from private latrines, taking into consideration the question of—

(1) Expense.
(2) Income to the municipality.
(3) The possibility or impossibility of irrigation of trenched land.

One solution of the difficulty would be by contract trenching as was formerly carried out by Major Ellis at the Meerut Grass Farm at the following rates :—

(1)	Rainy season	....	$60 \times 5 \times 1 = 300$	cubic feet.
(2)	Cold „	....	$50 \times 5 \times 1 = 250$	„ „
(3)	Hot weather	....	$40 \times 5 \times 1 = 250$	

at 3 annas per diem;

and trenching on the shallow system.

But it is an open question whether this work could now be done at these rates. There is also the difficulty of obtaining land near towns in sufficient amount to carry out the disposal of excrement on the Thornhill system.

S. A. HARRISS, M.B., C.M., D.P.H., D.T.M. and H. (Camb.),
Major, I.M.S.,
Sanitary Commissioner, United Provinces.

Municipality.		Receipts from conservancy.			Expenditure.					Total expenditure on conservancy (including road cleaning and watering) and latrines.
		Sale proceeds of night-soil and city sweepings.	Other conservancy receipts.	Total.	Establishment.	Cost and feed of live stock.	Plant and contingencies	Removal by contract.	Total.	
		Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Meerut ...	1910-11	10,990	862	11,852	29,432	...	4,437	...	33,869	32,611
	1911-12	12,871	860	13,731	29,957	...	5,960	.	35,917	31,512
Hapur ...	1910-11	6,020	3	6,023	8,614	...	1,350	...	9,964	10,248
	1911-12	7,557	...	7,557	8,748	...	1,327	...	10,075	10,770
Saharanpur ...	1910-11	2,836	2,626	5,462	20,823	3,287	2,975	48	27,133	30,735
	1911-12	3,791	4,451	8,242	22,271	2,643	3,922	36	28,872	32,385
Farrukhabad cum Fatehgarh	1910-11	18,244	84	18,328	13,182	1,203	15,937	...	30,322	31,302
	1911-12	18,317	169	18,486	13,604	1,481	14,350	...	29,435	30,501

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

DISPOSAL OF RUBBISH BY MEANS OF SMALL INCINERATORS IN THE CITY OF MADRAS.

BY

Doctor W. R. Macdonald, Health Officer, Corporation of Madras.

The usual methods of disposal of rubbish in India are by (1) dumping, (2) disposal into the sea, (3) incineration.

(1) *Dumping.*—On sanitary grounds this system of disposal is objectionable, even if the claim be urged that low grounds and useless lands can be profitably reclaimed by this means. When the dumping ground is far removed from a town or village the same sanitary objections may not hold good; but then the cartage of rubbish for long distances renders this method expensive. The danger of depositing crude rubbish in old wells, tanks, or low lands in or near the towns or villages cannot be over-emphasized, as pollution of air, water, and soil are assured concomitant evils well recognised. When to the ordinary removal of crude rubbish the conservancy of night-soil is linked the danger from this admixture is fraught with serious menaces to public health. It is under these conditions the "carrier" has his opportunity of sowing broad-cast his specific infection.

(2) *Disposal into the sea need not be considered.*

(3) *Incineration.*—For towns and villages this method of disposal is by far the safest and in most cases the cheapest way of getting rid of rubbish.

There are various kinds of destructors or incinerators on the market which when properly constructed and *managed* can be situated in any part of a town without giving rise to either effluvial or smoke nuisances. But the management of these large incinerators in the tropics, with a heavy rainfall to be coped with, and under most adverse conditions a sodden mass of rubbish, to which is added a large proportion of non-inflammable materials, has been quite overlooked until quite recently by most engineering firms engaged in the erection of incineration plant. How far the gas jet when installed in India will overcome these difficulties, has yet to be seen, when worked under Indian conditions.

The province of this paper does not however embrace a consideration of the larger destructors; but rather that of a two years' working experience in Madras in the disposal of town rubbish by means of small incinerators. Further the experiences recorded are not necessarily applicable to Calcutta or Bombay; but what perhaps may be claimed is that the system has proved a success in Madras sanitarily as well as financially and that it is a system that may be cheaply introduced into every smaller town or village in the tropics.

The orthodox teaching aforetime has been that small incinerators are more suitable for burning the rubbish of hospitals, jails and institutions and that perhaps under favourable conditions they might be of use in small villages with a population not exceeding 1,000 persons. Personal observations lead one to believe this is true, judging by the useless play-things seen in compounds, which are, neither, in capacity, or structure equal to consuming even one cartful of combustible rubbish per working day. These types however are not to be confounded with the special type experimented with in Madras City for over two years past.

Nature of town rubbish.—The rubbish of a Western town or village differs much from that seen in the East. The refuse of the house and factory contains much combustible materials in the form of cinders, pieces of coal and wood. Many kinds of incombustibles are separated as being of commercial value. Stable litter, manure and the sweepings of streets and markets may be said approximately to represent the remainder. In India vegetable refuse bulks largely in the ordinary house refuse; but inflammable materials in the form of coal cinders, pieces of coal or wood are almost universally absent. While stable rubbish may be similar to that found in the West, market, and street rubbish, has again a larger proportion of vegetable refuse. Non-inflammable materials in the form of empty tins of all sizes, brick-bats, broken earthenware, chatties, iron scraps, broken bottles, on the other hand, enter largely into the composition of the crude rubbish of an Indian town. The difficulties of combustion are still further enhanced during the rainy season when the rubbish is saturated with moisture, a condition unknown, to anything like the same extent, in Europe.

In view of the above comparisons of meteorological conditions, and quality of rubbish, the limited success attending the application of Western methods to Eastern conditions may be said to be due to

(1) nature of the rubbish to be disposed of, and

(2) the excess of moisture found in the rubbish especially during the monsoon.

But this does not entirely represent the cause of the partial failures in the working of large destructors installed in India in the past, with any degree of accuracy.

To the above may be added, (3) faulty separation of combustibles from incombustibles. Failure to fully appreciate the working limits of destructors have not been, in many cases, fully realised, with the result that furnaces have been charged with crude rubbish tipped direct from the cart. With the non-separation of incombustible materials, working according to this method, the inevitable result can only be a gradual daily diminution of calorofic efficiency with the too often hasty condemnation of so called antiquated destructors, and a clamour for an up-to-date installation capable of consuming mountains ! Experience, however, has revealed, that in order to abstract the highest standard of efficiency from incinerator in Madras, either large or small, a system of careful separation and screening had to be devised in order to attain the good results which we now claim in the disposal of Madras rubbish.

Area of the City of Madras.

27 sq. miles, or 17,280 acres.

Population as per Census of 1911—5,18,660.

Meteorological conditions—Rainfall.

A reference to the table reveals that September, October, November and December are the months in which most rain falls during the year. October and November give the highest records.

Statement showing the monthly and annual Rainfall of the Madras City for the last five years.

Years.	January.			February.			March.			April.			May.		
	No. of rainy days.	Rainfall.	Average rainfall.	No. of rainy days.	Rainfall.	Average rainfall.	No. of rainy days.	Rainfall.	Average rainfall.	No. of rainy days.	Rainfall.	Average rainfall.	No. of rainy days.	Rainfall.	Average rainfall.
...	0	0·11	0·84	0	0	0·29	0	0	0·36	1	0·12	0·63	0	0	1·91
...	0	0·02	0·84	2	0·48	0·29	0	0	0·36	0	0	0·63	0	0·07	1·91
...	6	5·42	0·91	0	0·65	0·29	0	0	0·35	4	7·52	0·63	4	9·49	1·88
...	1	0·20	0·52	0	0	0·23	0	0	0·21	0	0·04	0·40	0	0·01	0·90
...	0	0	0·58	0	0	0·23	0	0	0·21	0	0	0·40	0	0·01	0·90

Years.	June.			July.			August.			September.			October.		
	No. of rainy days.	Rainfall.	Average rainfall.	No. of rainy days.	Rainfall.	Average rainfall.	No. of rainy days.	Rainfall.	Average rainfall.	No. of rainy days.	Rainfall.	Average rainfall.	No. of rainy days.	Rainfall.	Average rainfall.
...	7	2·74	2·02	7	2·85	3·86	8	3·50	4·67	2	0·87	4·84	10	11·72	11·03
...	1	0·39	9·02	8	1·73	3·86	10	4·70	4·67	15	9·51	4·84	9	24·53	11·03
...	3	1·65	2·00	12	4·86	3·86	7	4·91	4·63	10	8·52	4·81	3	0·61	10·94
...	5	0·70	2·21	7	7·65	4·02	8	5·59	5·34	6	3·81	5·01	10	9·64	11·45
...	2	0·63	2·21	5	1·14	4·02	7	2·16	5·34	7	7·62	5·01	6	5·91	11·45

Years.	November.			December.			Annual.		
	No. of rainy days.	Rainfall.	Average rainfall.	No. of rainy days.	Rainfall.	Average rainfall.	No. of rainy days.	Rainfall.	Average rainfall.
...	12	16·25	13·29	7	6·49	5·37	54	44·66	49·11
...	9	12·07	13·29	3	1·38	5·37	57	54·85	49·02
...	4	3·73	13·13	4	0·89	5·37	57	47·65	49·11
...	10	15·78	14·08	0	0·05	6·02	47	44·47	50·39
...	9	12·69	14·08	10	6·37	6·02	46	36·53	50·39

Average for 40 years ending 1909.

Distribution of incinerators throughout the City.

A reference to table A will indicate the distribution of incinerators in the City of Madras. It will be observed that groups Nos. 7 and 16 have ceased working as reclamation of tanks has been completed.

A

Statement showing the distribution of small incinerators in the City.

Division.	Locality.	No. of incinerators.	REMARKS.
1	Sooriyanarayana Chetty Street	2	......
2	Narayanappa Naick Garden Monigar Choultry Road.	7	......
3	Basin Bridge Road, north of Cochrane Bullock Depôt.	7	......
7	Ammen Koil Street	4	*These are not working now since the work has been completed. Reclamation completed.
10	Yakoob Sahib garden, DeMellows Road ...	1†	
11	Sydenham's Garden	1†	
	Koravankulam in Avadanam Papier Street	2	
	Old Sheep Slaughter House Maidan ...	1‡	
	Hanumantharoyan Street	1†	
13	Egmore Paracherry...	2	
14	Between the Municipal Dhoby Khana and Chetput Railway Station.	1	
15	Thousand Light in Azizimulk Paracherry ...	1	
20	Elapatha Mada Koil Street	2	
16	Napier Park	1	*Not working as the work was over. Reclamation completed.

*Removed as reclamation completed.
†These incinerators are constructed at the expense of private parties.

B

Statement showing the places where the town rubbish was disposed of prior to the introduction of small incinerators.

No.	Locality of the place.	Division in which it is located.	Divisions which sent the carts for deposit.
1	Sewage Farm, Kassimode	1	Some of the carts of 1st, 2nd, 4th and 5th Divisions.
2	Low land near Hindu Burial Ground, Washermanpet.	3	Some of the carts of 4th, 5th, 6th and 7th Divisions.
3	Korukupet	3	The carts of 3rd Division and the remaining carts of 1st, 2nd, 4th and 7th Divisions.
4	Basin Road Incinerator	10	The carts of 8th and 9th Divisions, some of the carts of 10th, 11th and 12th Divisions.

No.	Locality of the place.	Division in which it is located.	Divisions which sent the carts for deposit.
5	Swampy Military land in Basin Road ...	10	Some of the carts of 10th—12th Divisions.
6	Brick Kiln Road	14	Carts of 13th, 14th and 16th Divisions and the remaining carts of 11th and 12th Divisions.
7	Kodampaukam	15	Carts of 15th Division.
8	Krishnampet Incinerator	19	Some of the carts of 17th, 18th and 19th Divisions.
9	Kurshid Ali Tank	19	Some of the carts of 18th and 19th Divisions.
10	Rifle Range	20	Some of the carts of 19th Division and those of 20th Division.

Table B gives a statement of the divisions formerly diverted to the various "dumping" grounds.

It may be noted that the distances for carting rubbish has been much curtailed by the distribution of the small incinerators particularly in the case of Korukupet. Other routes have also been equally shortened.

Description of the small incinerators in use.

These were designed and modified to suit local conditions by Mr C. L. T. Griffith, A M.I.C.E., (now Professor of Engineering College) while Engineer to the Corporation of Madras. It may be mentioned that his experiments were conducted under Monsoon conditions in the latter part of 1910. The structure is a brick masonry one, with three rows of iron bar superimposed and each row placed at right angles to the other, in the bottom of the furnace, ample draught apertures are allowed for, below, and above, is an upright masonry chimney on which is usually placed a 12'—16' iron chimney, an iron lid with a baffle plate is placed over the furnace, which is opened, and closed by means of a wire pulley attached high up on one side of the masonry chimney. The cost of erection is a recommendation also, as the masonry work is only Rs. 100, Rs. 25 for the iron chimney.

Separation of combustible from incombustible rubbish.

(1) By drivers, and sweepers in the divisions. In the forenoon trips a rough separation is made so that nearly all combustible material reaches the incinerator in the forenoon. What is left behind for the afternoon trips is nearly ashes, earth sweepings which contains a small quantity of organic matter. This is not usually taken to the incinerator but to the "Screeners" near by where combustible material is separated out and carried a short distance to the incinerator.

2. Separation—by hand, rakes and forks is the first operation on the arrival of the carts at the incinerators in the forenoon, women and boys do the light work of picking out brick bats, broken earthen-ware utensils, tins and other incombustibles.

3. Screening—after the bulky burning material is separated out from these incombustible materials a residue of earth, mixed with vegetable matter, smaller pieces of brick, bottle, etc., is left. This is then conveyed to the 'Screeners' for finer separation with the result that we have when screening operations are complete a finely powdered earth with a small quantity of organic matter. Night-soil has always been carefully excluded.

The " Screeners " are double, a large mesh one in front, a smaller mesh behind, so that we get double " Screening " with the same operation. The wire work of the "screener" is of expanded metal, the larger mesh being $1\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{8}''$ whilst the smaller is $\frac{1}{4}'' \times \frac{1}{4}'' \times \frac{1}{8}$." The frame work is of wood on which the expanded metal is fixed by bolts. The " Screener " is placed in an upright sloping position and is supported by two supporting wooden legs hinged to the upper part of the wood work frame.

C.

Statement showing the list of low lands and tanks reclaimed and are being reclaimed after the introduction of small Incinerators.

No.	Locality.	Division.	Particulars of work.	Amount of work in c. ft.	Remarks.
1	Parthasarathipettah Tank ...	19	Tank ...	91,000	Completed.
2	Egmore Paracherry ...	13	Tank and low land...	1,25,500	Under progress.
3	Chetput near Dhoby Khana ...	14	Lowland ...	94,400	Do.
4	Avadanam Paupier Road ...	11	Koravankulam and the lowland around the Incinerator.	3,63,000	Do.
5	Site for the Cochrane Depôt drivers' lines.	3	Lowland and tanks	1,07,500	Completed.
6	Reliance Foundry	3	Lowland and tank	4,18,900	Under progress.
7	Ammen Koil Street	7	Do. ...	94,000	Completed.
8	South of Krushnampet Depôt (site for drivers' lines).	19	Lowland ...	1,82,500	Do.
9	Sheep pen, Kobe Lodge ...	10	Raising the level ...	1,11,000	Do.
10	Napier Park	16	2 tanks ...	5,10,000	Do.
11	Suriyanarayana Chetty Street ...	1	Lowland and tank ...	1,42,019	Under progress.
12	Narayanappa Naick St. ...	2	Lowland with two tanks.	12,21,997	Do.
13	Sydenham's garden ...	11	Tank ...	1,46,290	Do.
14	Old Sheep Slaughter House Maidan.	11	Tank and lowland ...	2,96,000	Do.
15	Yaqub Sahib Garden ...	10	Do. ...	1,93,800	Do.
16	Three tanks in Barbers Bridge Road.	19	3 tanks ...	1,11,260	Finished.
17	Major Elliot's Bungalow, Egmore	1	Tank	2,31,000	Under progress.
18	De'Mellow's Road, south of the big incinerator.	10	Lowland ...	9,55,680	Do.
19	Padavattammen Koil St. ...	7	Tank	34,530	Completed.
20	Kollawar Agraharam St. (United F. C. M. Hospital compound).	2	Tank	3,57,800	Under progress.
21	Salt and Abkari Lascars' Lines ...	3	Tanks	37,500	
22	Sundram Pillai St.	11	1 tank	86,562	Under progress.
23	Azizimulk Paracherry ...	15	Lowland and tank...	1,21,350	Do.
24	Pathirthotam Tank	20	Tank	26,000	Do.
25	Elapatha Mada Koil Burial ground	20	Do.	13,413	Do.

Quantity of rubbish disposed of by the small Incinerators.

Table D gives a statement of the number of small incinerators at work and the total amount of crude rubbish disposed of during 1911-12. This works out at about 11¾ cart-loads per day for each incinerator during the year. Experiments conducted to ascertain the maximum working efficiency of each, however, shows that up to 30 cart-loads of sun-dried rubbish can be disposed of during a working day. 15 cart-loads per incinerator per working day has been found not to over-tax the energies of the coolies employed in separating, screening, stoking operations, and reclamation work: but under favourable weather conditions to increase the consumption of rubbish, all that is required is to strengthen the usual working staff by 2 or 3 extra coolies. The total of column 3 represents non-combustibles separated at the incinerators, from the rubbish carted from the forenoon and which has been subjected to rough hand separation in the divisions by the drivers and sweepers. Column 4, on the other hand, is composed of almost entirely of non-combustible rubbish removed from the divisions after the inflammable materials have been disposed of. This is separated, and screened at the tanks, or lowlands being reclaimed, and combustible materials are then removed to the incinerators. To this quantity has to be added the ash from the incinerators which is mixed with the screened earth. The percentage of ash to burnt rubbish is about 33 per cent.

The above does not, however, exhaust our resources for reclamation purposes, as the two large incinerators where separation and screening is conducted on the same lines as at the small incinerators, give approximately about the same quantity of non-combustibles, screened earth, and ash. Further, to this is added silt from side drains, earth sweepings from the streets, house building, and demolishing debris.

D

ON PAGE 8.

Statement showing the work turned out at the Small Incinerators in the City from 1st April 1911 to 31st March 1912.

—	Locality of the incinerators.	—	No. of Carts-load of 1 Rubbish received including Combustibles and Non-combustibles.	2 Combustible Rubbish Burnt.	3 Non-Combustibles separated at the incinerators from the Divisional Carts.	4 Non-Combustible earth, etc., brought in the afternoon after separation in the Division.	Remarks.
1	Surya Narayana Chetty Street.	3	10,672	7,115	711	2,846	
2	Tinnevelly Settlement ...	7	28,081	18,721	1,872	7,488	
3	Cochrane Road ...	7	29,491	19,661	1,966	7,864	
7	Ammen Coil Street ..	4	13,536	9,024	902	3,610	
10	Yacoob Sahib Garden ...	1	270	180	18	72	
11	Koravan Colam ...	2	12,638	8,426	842	3,370	
12	Sydenham's Road ...	1	6,307	4,205	420	1,682	
13	Egmore Paracherry ...	2	10,647	7,098	710	2,839	
14	Chetpet	1	5,340½	3,560	392	1,388½	
15	Thousand Lights ...	1	4,289	2,860	286	1,143	
16	Napier Park	1	6,521	4,348	435	1,738	
20	Mantha Valli and Elapatha Madha Coil Road.	2	4,919	3,280	328	1,311	
	Total ...	32	1,32,711½	88,478	8,882	35,351½	

Staff for working at the Large and Small Incinerators in the City.

Staff for large Incinerator.	No.	Monthly.	For 12 Months.	Staff for small Incinerator.	No.	Monthly.	For 12 Months.
		Rs. A. P.	Rs. A. P.			Rs. A. P.	Rs. A. P.
Firemen at Rs. 10 each ...	6	60 0 0	...	Men Coolies at Rs. 7 each ...	3	21 0 0	...
Platform Maistries at Rs. 9 ...	2	18 0 0	...				
Do. Men Coolies „ 8 ...	20	160 0 0	...				
Do. Women Coolies Rs. 5.	16	80 0 0	...				
Do. Boy Coolies Rs. 3-8	12	42 0 0	...				
Ash Coolies Rs. 8 ...	3	24 0 0	...				
Total ...	...	384 0 0	3,608 0 0	Total ...	...	21 0 0	252 0 0

Site for Incinerators.

These are selected with the following considerations in view up to date :—

(1) Adjacent to a tank, or low lying ground, to be reclaimed.

(2) On a site not liable to inundations during the rains.

(3) On open land at some distance from dwelling houses.

(4) On the site most conveniently situated for conservancy of surrounding divisions.

Reclamation of tanks and low lying lands.

The selection of site indicates one's premier intention with regard to the eventual disposal of screened earth, and ashes from the incinerators—the reclamation of tanks, and waste lands.

Table C attached will give some idea of what has already been accomplished in Madras.

At first it was found that "dumping" screened earth directly into a tank, or spreading at some depth on low lands, gave rise to some fermentative processes, with the evolution of gases, and heating. This fermentative process was particularly noted in water, and later, on low-lands where trees had been prematurely planted. As a preparatory measure the screened earth is now spread out in the sun for two, or three days, so that on land reclaimed by this screened soil, mixed with the ash there is but little fermentation, and the soil soon becomes "dead" and fit for planting on, in a short time.

At no time has nuisance ever been noted from this method of reclamation, although in some cases dwelling houses were near. But too much care cannot be exercised in the supervision of "screening" operations, so that no rank organic matter is allowed to be deposited. From this defect alone failure would be incurred. In this method of reclamation one may fairly claim a sanitary position much in advance of that offered by the old system of "dumping rubbish," in that, it is a sanitary disposal, and may be safely utilized within the precincts of a town, or village and thus give four advantages :—

1. Sanitary disposal of rubbish.

2. Reclamation of tanks, and insanitary low lands.

3. Reduction in cartage charges, as long journeys to dumping grounds are unnecessary, so long as tanks and lands are available.

4. Reduction in the cost in the erection of incinerators. Ten small incinerators at Rs. 125 = Rs. 1,250, the working capacity of which equals either of the two large destructors in this city which cost Rs. 1,00,000 and 16,000 respectively for erection.

Financial aspect of the question (vide *Table D*).

As these incinerators were located near the sites of reclamation, it was found possible to effect a considerable reduction in the conservancy carts. Beginning from September 1910, 72 box carts were dispensed with. First only 29 carts were done away with, but in the course of the year all had been stopped. During the latter part of the year some of these carts were employed for reclaiming places such as Kalyani Hospital low-land, and also a large tank at Teynampet where it was found that these small incinerators could not be conveniently worked.

Thus, owing to the reduction of carts, the actual expenditure under "Maintenance of bullocks" was Rs. 2,33,889-7-9, while the amount budgetted being Rs. 2,64,495-0-0. These savings include also a sum of Rs. 12,800, being the unspent amount under purchase of bullocks. (*Vide infra.*)

During the year 1910-11, in addition to the said savings, a sum of Rs. 75,000 provided for the construction of a large incinerator on the western side of the city with Rs. 8,000 for the working expenditure of this incinerator and Rs. 7,527 being the cost of prepared earth, and ashes supplied for the reclamation of low lands, Municipal roads, etc., were saved. This is much less than an engineering estimate. The prepared earth and ashes, under reference were supplied from the large incinerator in Krishnampet.

Though there were 22 small incinerators working in the city during 1910-11 no sum was spent, in shape of working expenses, as necessary labour was taken from the staff budgetted for the rubbish depositing places, which ceased to be so, after the introduction of small incinerators. But only Rs. 1,160 was paid for their construction.

From 1st April 1911, a recurring saving of Rs. 2,376 per mensem or Rs. 28,512 per annum was effected owing to the reduction of bullocks and staff required for the 72 box carts noted *supra*. It was also found then necessary to reduce even the rubbish carts as the sites for reclamation were within easy reach of the small incinerators. The number of such carts reduced from 1st April 1911 was 37—33 rubbish carts, 3 trollies and 1 lorry. The saving effected from the reduction of these carts was Rs. 1,216-8-0 per mensem or Rs. 14,598 per annum. Thus from 1st April 1911, it was found to save Rs. 3 592-8-0 per mensem or Rs. 43,110 per annum from the reduction of the said carts, which is due to the introduction of these small incinerators.

During the year 1911-12, the amount budgetted under "Maintenance of bullocks" was Rs. 2,24,190 and the expenditure under this head was Rs. 1,71,489-1-6. The savings here are mainly due to cheap rate of fodder for bullocks as compared with the previous year. In addition to the said saving, a sum of Rs. 5,000 was saved in the budget allotment for purchase of bullocks, since only a sum of Rs. 10,000 was provided instead of Rs. 15,000 as in previous year.

Reclamation works at a cost of Rs. 6,497-3-8 were done during 1911-12, with the reduced complement of bullocks and carts. The said amount includes also a sum of Rs. 2,000 being the amount demanded from private parties for reclaiming their low-lying lands, and tank. These works are under progress.

During the year, a sum of Rs. 4,370-9-11 was spent for working these small incinerators.

E.

Statement showing the savings effected by the introduction of small Incinerators in the City of Madras, vide *Table No. 23-A., in Appendix II of the Administration Report, 1911-1912.*

Particulars.	1910-1911.			1911-1912.		
	Budget Grant.	Actual Expenditure.	Savings.	Budget Grant.	Actual Expenditure.	Savings.
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Maintenance of Bullocks	2,64 495 0 0	2,33,889 7 9	30,605 8 3	2,24,190 0 0	1,71,489 1 6	52,700 14 6
Provision for putting up a large Incinerator in Brick Kiln Road ...	75,000 0 0	...	75,000 0 0	...	...	...
Recurring Savings by the reduction of 72 Box Carts	...	...	...	...	...	28,512 0 0
Recurring Savings by the reduction of 33-R. C., 3 Trollies and 1 Lorry ...	...	...	...	...	...	14,598 0 0
Reduction in the usual provision for purchase of Bullocks	...	...	...	...	...	5,000 0 0
Cost of Reclamation Works	...	...	7,527 0 0	...	...	6,497 3 8
Total Savings	...	...	1,13,132 8 3	...	...	1,07,308 2 2
Deduct—Amount spent for the construction and working of Small Incinerators	...	...	1,160 0 0	...	...	4,370 7 11
Net Savings	...	...	1,11,972 8 3	...	...	1,02,937 10 3
Total savings for the year 1910-1911 and 1911-1912 ...	...	...	...	...	...	2,14,910 2 6

Concluding remarks.

I. *Incineration of night-soil mixed with rubbish.*—Experiments were conducted in the disposal of night-soil along with rubbish at Chetput by means of one of these small incinerators, for about one month.

Night-soil was procured from the two sanded latrines in the paracheries near by. It was free of liquid, but slightly mixed with sand. About 15 cart loads of suburban rubbish were brought in daily. After separation and screening night-soil was freely mixed with the rubbish and then transferred to the incinerator furnace. So far as the disposal of the night-soil was concerned the results were eminently satisfactory, as the night-soil of 400 persons (half the population of the paracheri) could be disposed of daily without difficulty. The gases given off from the incinerating night-soil, however, proved such a vile nuisance, that I was compelled to discontinue these experiments. I am of opinion, however, that by using a *dome* incinerator this nuisance can be effectively controlled.

II. *Incineration during the monsoon.*—It will be seen on reference to the meteorological table that most of the rain for the year in Madras City falls during the months of September, October, November and December. When rain falls continuously for a day, or longer, conservancy operations are entirely suspended so far as the removal of rubbish is concerned; but when rain falls during some part of the day, or night, incineration operations are retarded on account of the sodden condition of the rubbish brought in. To combat this condition various measures have to be adopted. The rubbish is separated in the usual way, and spread out to dry in the open when sunshine is available, or under a *kutcha* shed. One's experience in Madras has been that rubbish spread out for a short time in the sunshine and then sprinkled with crude kerosine oil can be disposed of by these small incinerators. Screening operations, however, have to be suspended temporarily until most of the moisture has been removed.

The question of small drying sheds similar to those in use on tea gardens for drying wet green leaf, may have to be considered when the rainfall exceeds that of Madras City; but as yet one's experience does not suggest the need of them here, as sun-drying, along with a sprinkling of crude kerosine oil has been found sufficient, so far.

One is constrained to believe that these small incinerators for the disposal of rubbish in Madras City have proved a sanitary, and financial success, and that there is an important place for them in connection with conservancy in moffusil towns, and villages in India, and Burma, where the rainfall is not excessive.

DISPOSAL OF RUBBISH BY MEANS OF SMALL INCINERATORS IN THE CITY OF MADRAS.

SUMMARY OF PAPER BY DR. W. R. MACDONALD, HEALTH OFFICER, CORPORATION OF MADRAS.

After discussing shortly and dismissing other methods of rubbish disposal incineration is gone into fully as "by far the safest and in most cases the cheapest way of getting rid of rubbish."

Previous partial failures of the application of western methods are attributed to

(1) the less combustible nature of the rubbish to be dealt with,

(2) the excess of moisture in it especially during the monsoon,

and (3) a faulty separation of the combustibles from the incombustibles.

The conditions obtaining in Madras are then described—rainfall—type of incinerators used—their distribution throughout the city—the method of working them and the financial aspect of the subject.

The advantages of disposal of rubbish by small incinerators are given as—

(*a*) It is a sanitary disposal.

(*b*) Tanks and insanitary low lands can be reclaimed.

(*c*) Cartage charges are reduced.

(*d*) Small incinerators are much cheaper than a large one for the same amount of disposal.

A warning is given that night-soil must not be mixed with the rubbish or much nuisance arises.

Note on the Sullage Farm at Agra.

This paper is written with a view to encourage the disposal of the sullage of towns on farms. The points requiring special notice are :—

(i) Conduct of farm.

(ii) Character of soil, measurement of porosity.

(iii) Proximity to towns in relation to after-effects on general health.

(iv) Income.

The Agra Sullagé Farm is situated in the dry bed of the Jumna about 300 feet from the walls of the Agra fort from which it is separated by a road and a channel of the river. The sullage was first lifted on to the farms by bhokas in May 1903 and run on to the farm by a carrier pipe in August 1905. The total area of the farm in 1908 was 60 acres and in 1911 43 acres 2 roods 35 poles or 76 bighas and 15 biswas, but during the present season the river current, which for several years impinged the opposite bank, has now set in towards the fort side of the river and has already washed away an area of about 8,410 square yards. If this continues the farm is doomed and the sullage and sewage will require to be raised by a pump and passed through an iron pipe supported on piers of the railway bridge to a new farm on the opposite side of the river.

The sullage of the city was formerly discharged into the river at two points, the first between John's Ice Factory and the railway bridge near the fort, and the second to the fort side of the Bombay Baroda and Central India bridge. The first point of discharge was eliminated by the formation of a supplementary interception drain built in 1909-10 which carried the sullage to the junction with the main drain. The main intercepting sullage drain and the new supplementary drain along the Strand road (which are the principal arteries of the Agra drains) converge and discharge into an ovoid sewer (lately built) which runs along the eastern side of the Strand road in front of the fort for a distance of some 900 feet. From this point the sullage is led in a 30 inch pipe for a distance of 190 feet across the narrow channel of the Jumna on to the farm by which it progresses in a rectangular shaped channel, lined with bricks set in mud to a point exactly opposite the south-eastern area of the fort. The remaining channels of supply to the various khets or fields are all unlined. The main channel finally discharges directly into the river some 4,050 feet from its commencement. There were originally no openings except manholes in the iron pipes of the main distributary for 450 feet from the edge of the Strand road. This condition has lately been modified owing to the land opposite the north-west corner of the fort being cut away by the river.

The amount of sullage discharged daily into the farm in winter is about 750,000 gallons and in summer about 1,000,000 gallons. In summer the whole of this is used in irrigation, but in winter and during the rains the greater portion discharges directly into the river. It is also discharged directly into the river when the sub-soil water rises to within 2 feet of the surface of the sand bank. To estimate the rise in ground water a well has been sunk on the farm. No irrigation is

permitted on the portion of the sand bank between the main carrier and the railway bridge. A hedge of castor-oil plants and shisham trees has been planted to the west and parallel to the main distributary from its commencement to a point opposite the well on the river side of the Strand road to screen off the farm and form a boundary.

The main channel has a tendency to silt up and is kept open by scraping the bed daily with a board affixed to the base of a frame. One man leans his weight on the frame and two men are on either bank—pull the board along by wire ropes.

I.—Conduct of the farm.

It will be noted from the above description that the whole of the sullage is employed for irrigation during the summer, but that in winter and the rains, and also when the sub-soil water rises to within 2 feet of the surface of the farm the sullage is passed directly into the river. This, where the river is of large volume, is unimportant, as is the case in Agra.

Sullage farms, as for example the two at Lucknow, have usually hitherto been run with a view to profit only, but should be farmed more with a view to the disposal of the whole of the sullage than with the object of obtaining income from crop cultivation. The land on which a sullage farm is placed should therefore belong to the municipality and if leased out a certain portion should be retained for the disposal of sullage at those seasons when the cultivator does not require it for crops. The failure to carry out these rules has given rise to contamination of small rivers, &c.

II.—The Character of the soil.

The character of the soil is of the utmost importance. In choosing a site for a sullage farm, good sandy loams are the best; admixtures of clay are inimical to its working. The porosity of the Agra sullage is seen by the fact that when the surface is covered to a depth of approximately 6 inches the water disappears in three hours. The porosity of the soil has also been measured by Dr. Haffkin's porosimeter. The apparatus is constructed as follows :—

The upper end of a petrol drum is removed leaving a cylindrical vessel of 10 inches diameter. Two small tubes are soldered into holes made for the purpose in the bottom of the cylinder. One tube is connected to a mercurial manometer, the other with two large bottles arranged similarly to an aspiration apparatus.

For use the cylinder is placed mouth downwards on the soil. It is then driven into the soil by blows from a heavy mallet. The cylinder is protected by a disc of wood.

After the cylinder has been driven into the soil to a depth of about 16 inches the rubber tubes are placed on the pipes. One large bottle filled with water is placed at a height of 7 feet from the ground, and is furnished with a tap. From the tap an Indian rubber tube leads to a tubular opening in the bottom of the second bottle. This bottle which is graduated is placed on the ground. On opening the tap water accordingly flows from the first bottle into the second and displaces the air. The mouth of the second bottle is closed with a cork through which is passed a piece of glass tubing. This is connected with rubber

tubing to one of the metal tubes soldered into the drum. In carrying out the experiment the time required for the passage of five litres of air is disregarded and the time required for the passage of the second five litres is measured.

III.—Proximity to town.

The Agra Farm is within 300 yards of the fort.

In 1908 and 1909 the military authorities complained that the health of the fort was seriously affected by the sullage farm. The Local Government appointed a committee to enquire into this charge. Two of the most important questions on which the committee were asked to adjudicate were as follows :—

A.—Whether the present system by which the sullage water of the Agra city is utilized on a sullage farm outside the fort is or is not injurious to the health of the military population?

B.—Whether it proves a nuisance or not?

A.—It was proved that—

(1) Anopheles did not breed on the sewage farm as the oxygen-free sullage was inimical to the growth of algae which is the main food of anopheles larvae. In the absence of anopheles fever rates could not be affected.

(2) That the rates for admission for intermittent fever from 1901 to 1907 were as follows :—

1901.	1902.	1908.	1904.	Total.	Yearly average for these four years.	1906	1907.	Total.	Yearly average for these two years.
158·2	309·2	382·8	268·7	1118·9	279·7	115·3	181·2	296·5	148·2

The admission rate for Agra fort in triennium, 1905 to 1907, compares favourably with the other forts in India.

	Malarial fever.	Enteric fever.	Dysentery and diarrhoea.	All causes.
Agra	124·5	25·6	1·2	803·2
Delhi	642·2	15·1	19·4	1,278·0
Lahore	160·5	25·1	36·6	1,094·3
Calcutta	199·9	3·7	27·6	1,102·1
Ferozpore	213·3	20·8	21·5	891·3

The cause of the malaria was due to the irrigated grass plots in the fort to the moat, the Jumna river, the small collections of water in the fort and the grass farm at the back of the fort.

The conclusions of the Committee were that they did not consider "the present system by which sullage water of Agra city is utilized in a sullage farm outside the fort has been proved injurious to the health of the military population.

(1) Malaria is stated to have increased, but this is unlikely to have been caused by the sullage farm, as sullage is an unsuitable liquid for the breeding of fever-bearing mosquitoes (anophelines), due to the absence of their natural food, algae, which, we consider, cannot grow in a nearly oxygen-free liquid like sullage. (Hankin.)

The difference in the number of admissions for malarial fever in the fort and cantonments is an unreliable test of the actual number

who are infected in one place and develop in the other, or a relapse may be mistaken for a primary attack and the conditions of the place where the relapse takes place may be considered in fault; for such reasons Captain Lelean in his answer to question 282 candidly admitted the unreliability of the statistics brought to show that disease is caused by the sullage farm.

(2) Diarrhoea and dysentery, which might reasonably be considered as favoured by exposure to sewage effluvia, have decreased among the troops in the fort.

(3) Other acute diseases.—No evidence that they are caused by the sullage farm has been brought forward.

(4) Anaemia and debility have been stated to be caused by residence in the fort. Lieutenant Scatchard in his answer to question 343 stated that they may be due to malaria.

The committee have consulted various works, which refer to the effect of sewage farms on health.

Parkes and Kenwood in their book entitled "Hygiene and Public Health," published in 1902, page 228, state that "in the open air of the country excretal and other offensive emanations are rapidly diluted and oxidized and rendered practically harmless. In this way we can account for the excellent health enjoyed by the workmen on sewage farms and by those who live in the neighbourhood, as well as by the men engaged at sewage works."

We gather from Stevenson and Murphy in volume I, page 885, of their "Treatise on Hygiene and Public Health," published in 1892, that there is very little evidence of disease being caused even by badly conducted sewage irrigation. An outbreak of dysentery and diarrhoea in 1864-5 at the Cumberland and Westmoreland asylum was reported as due to the sewage farm, which was in close proximity, but it appears that strong and putrid sewage became ponded on the irrigation plot, forming a filthy morass. Sewage is still applied on the grounds of this asylum, with the difference that irrigation is conducted on proper principles. The medical officer now states that no disease or nuisance in any way arises from the irrigation by sewage. There is, besides, evidence to show that the resident population of sewage farms shows a very low rate of mortality and that the people are quite as healthy as the labourers on ordinary farms, for example, in England. From the returns of nine farms it appears that the death-rate amongst the residents on the farms on an average of the number of years which they had been in operation, does not exceed three per 1,000 per annum. This rate is very likely not lower than that which would obtain amongst ordinary agricultural labourers, but still it shows that sewage farming is not detrimental to health or life.

To quote verbatim from the official report of the sewage farm at Gennevilliers near Paris :—

"The sanitary condition leaves nothing to be desired. For several years it would be impossible to bring forward a single instance of any shadow of complaint on this subject."

Given by Lieutenant-Colonel Caldwell, R.A.M.C., in the Journal of the Royal Institute of Public Health for March 1908.

The fifth report of the Royal Commission on Treating and Disposal of Sewage, dated the 7th August 1908, states that no proof has yet been furnished of direct or widespread injury to health in the case of well managed sewage farms. It is interesting to note here that the report for 1905 on the sewage farm of Berlin contains the following statement:—" We can only repeat here what we have said in previous reports—that the sewage treatment (Rieselbetrieb) has had no injurious effect upon health."

This farm covers an area of nearly 39,000 acres of sandy soil, and there was on the ground in 1905 a resident population of 4,198 persons.

In India an excellent example is the very healthy condition of the jail population, where all the night-soil is trenched in jail gardens, frequently in very close proximity to the barracks.

The committee, having considered the evidence given by the different witnesses as to whether the sewage farm does or does not give rise to a nuisance, are of opinion that the sewage farm does at certain times give rise to a nuisance from smell.

The evidence shows that the nuisance mainly arises from the main carrier between the point where it leaves the metal carrier and becomes an earth channel and the point where the main distributary carrier is taken off at right angles. Between these two points the channel has been allowed to widen out to a width five or eight times that of its proper breadth for a distance of about 150 yards : on this account the flow of the sullage water in that portion of the main carrier has been much retarded, thus allowing a deposit of sludge to take place and the decomposition of this sludge caused by bacterial action at a high temperature gives rise to offensive gases as evidenced by the bubbles of gas which are seen bursting on the surface of the sullage—in fact this is practically an open septic tank giving rise to a nuisance.

In the subsidiary channels, when there is a good fall and the sullage is flowing fairly fast, bubbles of gas to much less extent are given off and the smell is barely perceptible.

B.—As regards nuisance arising from the soil of the farm the evidence shows that there is practically no sewage smell from the surface of the farm in dry weather. But it is very probable that smell may be given off from the smaller subsidiary channels at times if the sullage water is allowed to stagnate in them, although no smell was noticeable when the committee visited the sewage farm.

From the evidence given before the committee the nuisance from the smell appears to be worse in the months of June, July, August and September, that is just before the rains and immediately afterwards.

When the iron carrier is removed sullage is not put on to the farm. Any smell at that time must arise from the outfall of the sewer into the river channel between the island and the Strand road, or from the dilute sewage in the channel.

The witnesses who complained of the nuisance from smell stated that the smell is noticed chiefly at night and when the wind is blowing from the direction of the east or north-east. Only one or two of the witnesses said that they noticed the smell also in the mornings. There

4.c.c

is no water logging of the soil during the dry months, but it is possible that at the commencement of the rains there may be some water logging, as at this time the level of the sub-soil water would be gradually raised and the evaporation from the surface of the farm would be considerably less.

The following quotation is taken from the fifth report of the Royal Commission on Sewage Disposal, page 232 :— "All sewage works are liable at times to give off unpleasant smells; they should therefore be situated away from dwelling houses whenever this is practicable."

"The committee consider that any nuisance complained of must be due to mismanagement, that is allowing pools of sullage to form, as the soil of the sullage farm is well adapted for irrigation with sullage or sewage as it is extremely porous, and the sullage applied to it since 1905 has not been excessive; this is shown by Dr. Hankin's evidence and report. The committee are satisfied from the excellent condition of crops on the land that it has not been over-manured with sewage; if the land were sewage sick, the indifferent crops upon it would soon show it."

IV.—Income.

The fourth point is the income accruing to a municipality by the disposal of sullage in this method.

The soil on which the farm is situated was originally silt from the Jumna, was nazul land and was absolutely worthless. It brings in now an income of Rs. 73 a bigha or a total of Rs. 5,625 per annum. The crops grown on this land are principally sugarcane, tobacco and winter cabbage and occasionally Indian corn. The sugarcane crop is one of the finest extant—the weight of cane obtained is 600 maunds per acre. The variety of cane grown is Thoon and is entirely used for eating purposes and not for the production of gur or raw sugar.

V.—The method of letting out the sullage farm.

The farm is let out to a head tenant who sublets it to others. The tenants can be punished before the honorary bench of Magistrates for not carrying out rules regarding the proper utilization of sullage by prosecution for creating a nuisance.

For those who take an interest in the subject a resumé is appended of Dr. Hankin's work on the bacteriology of the sullage, of the soil of the farm, and of the sediment in the main drains, on the analysis of the gas liberated from the main drains, and on the measurement of the amount of the gas and the number of microbes present in the air over various points of this drain.

In view of the findings of the committee the point of greatest interest to the practical sanitarian is contained in the analysis of the sub-soil sullage water of the farm 10 feet below the surface.

The albuminoid ammonia is reduced from ·6 to ·006 and the free ammonia from 3·8 to nil. The nitrates have increased from 0 to 1·84. The oxygen absorbed in four hours is reduced from 18 to 1·5 and the chlorine from 25·9 to 3·5.

VI.—Bacteriological tests of the earth of the sullage farm.

The following figures give the average number of microbes detected per gramme of soil at the places indicated:—

(i)	Surface soil not recently treated with sullage ...	370,000
(ii)	„ „ recently „ „ „ ...	2,980,000
(iii)	Soil recently irrigated with sullage 1 foot from surface ...	2,250,000
(iv)	„ „ 2 feet „ „ ...	600,000
(v)	„ „ 3 „ „ „ ...	160,000
(vi)	„ „ 4 „ „ „ ...	90,000
(vii)	„ „ 5 „ „ „ ...	40,000
(viii)	„ „ 6 „ „ „ ...	4,000

This estimation was at the end of 24 hours growth in Agra.

At the end of three days growth the increase in numbers was as follows:—

	Times.
In soil 1 foot from surface	2·3
„ 2 feet „ „	2·8
„ 3 „ „ „	7
„ 4 „ „ „	9·5

On digging holes into the sand of the sullage farm it was found that the discolouration of the sand produced by sullage did not extend to a greater depth than 3 feet.

Analysis of specimens of earth:—

	Moisture.	Organic matter.
(1) Earth from surface in fields near hut on sullage farm; it had been irrigated on previous day, and four times previously	21 per cent.	1·58 per cent.
(2) Earth one foot below surface from a sugarcane field on sullage farm; the crop had been cut a month previously	8·5 „	1·68 „
(3) Earth six inches below the bottom of a distributary drain which was dry at time of collecting sample	26·4 „	4·86 „
(4) For comparison earth from Chemical Examiner's compound	1·3 „	2·73 „

The analysis of the sullage water is as follows :—Parts per 100,000 collected at—

	6 30 a m.	Main drain 9.30 a m.	3.30 p.m.	8.0 p. m.	End of distributary 3.30 p.m.
Sulphuretted hydrogen ..	0	0	0	0	0
Free ammonia	2·22	3·5	3·0	2·23	3·8
Albuminoid ammonia ..	·6	·9	·75	·6	·52
Nitrites	0	·023	·028	9	0
Nitrates	0	·012	0	0	0
Total organic nitrogen ..	..	2·4	2·2	..	1·7
Oxygen absorbed (4 hrs. at 80°c)	15	20	18	15	18
Chlorine	15·5	22	19·5	14·8	25·9
Solids in solution	50	70	70	65	100
Solids in suspension ..	75	150	145	115	108

VII.—ANALYSIS OF GROUND WATER BENEATH SULLAGE FARM.

From an excavation about 10 yards from the end of the main drain sub-soil water was met with at a depth of about 10 feet.

The results of the analysis of this sullage: Parts per 100,000.

Sulphuretted hydrogen	0
Free ammonia	0
Albuminoid ammonia	·006
Nitrites	0
Nitrates	1·84
Total organic nitrogen	...
Oxygen absorbed (4 hrs at 80°c)	1·5
Chlorine	8·5
Solids in solution	90
Solids in suspension...	4

The amount of bacteria in the sullage was as follows. From sullage water collected on October 13th the number of microbes per c. c. were as follows:—

(1) Commencement of main drain...	15,968,000
(2) Commencement of main drain from bottom sediment ...	11,520,000
(3) First distributary on left, near main drain	448,000
(4) Sullage on newly irrigated field on to which water was flowing at the time	1,024,000
(5) First distributary on left, containing culex larvae ...	420,000
(6) Main drain at end near the river	3,200,000
(7) A distributary in which water was running slowly ...	720,000
(8) Same distributary further on where it had entered sugar-cane field	4,000,000
(9) Standing water in a field near look out in which water had been run on recently for the third time ..	4,630,000
(10) Standing water in blocked drain	270,000
(11) Standing water in cabbage field, second irrigation ...	3,500,000

Another series of specimens of sullage:—

(1) Commencement of main drain	5,600,000	4,400,000
(2) First left branch distributary ...	5,760,000	3,500,000
(3) Bottom water of main drain ...	4,220,000	4,140,000
(4) Water filtered through an earthen dam on second left distributary	7,600,000	7,640,000
(5) End of main drain	8,400,000	7,200,000
(6) Standing water near look out on left side of main right distributary	10,240,000	11,260,000
(7) Main distributary near look out ...	6,440,000	5,820,000
(8) Standing water in sugarcane field ...	8,360,000	11,080,000
(9) „ „ open field ...	3,800,000	5,600,000
(10) Main distributary, 100 yards south of look out	5,400,000	4,040,000
(11) „ 200 yards ...	2,420,000	3,720,000
(12) „ 300 yards end of main distributary	5,160,000	6,600,000
(13) Moat, corner near railway	18,800	33,000
(14) Water draining out of moat at east of Strand road	8,400	13,200
(15) Moat near Jehangiri Mahal	6,000	6,000
(16) „ Jasmine tower	4,400	5,200

Observations on the anaerobic bacteria in the sediment of main drain on November 1st.—

	Aerobes.	Anaerobes
Surface sullage water	5,720,000	3,350,000
Sludge bottom of main drain	900,000,000	725,000,000

The sediment was cleared out of the drain on the 3rd November and observations taken on the 4th November.

		Microbes per c. c.
(1)	Commencement of main drain 2 inches from surface.	1,600,000
(2)	" " 5 " "	1,600,000
(3)	" " 8 " "	1,760,000
(4)	" " 11 " "	2,260,000
(5)	" " 14 " "	2,280,000
(6)	" " 17 " "	4,500,000
(7)	" " 20 " "	70,000,000
(8)	End of drain surface water	1,520,000
(9)	" " bottom "	90,000,000
(10)	" " " "	120,000,000

There is a vigorous bacterial growth in the sludge that lies at the bottom of the main drain. The growth is anaerobic and favours the production of sewer gas.

Analysis of gas liberated from main drain collected early in November.

	Per cent.
Gaseous nitrogen compounds	·5
Sulphur compounds	1·1
Oxygen	3·0
Hydrogen	3·75
Carbon dioxide	20·4
Nitrogen	22·5
Marsh gas	48·75
	100

An apparatus was designed to measure the gas liberated from the main drain. This apparatus consisted of a circular cylindrical vessel with a bottom area of 3 square feet. The bottom was in the form of a depressed cone. A wide glass tube was inserted at the highest point and connected with India rubber to a suitable aspiration apparatus. On November 9th, at 10 a.m., at the centre of the main stream 230 cubic centimetres of gas were given off in a quarter of an hour and at 4 p.m. on the same date 400 cubic centimetres. On the 21st of November at midday a series of observations commencing at a point 50 yards below the commencement of the main drain and continuing at intervals of 10 yards towards the lower end of the drain gave in 5 minutes 160, 160, 95, 570, 270, 180, 340 and 130 cubic centimetres. The main drain is 144 yards in length, its area is 2,880 square feet. The amount of gas given off is between 30 and 230 cubic feet per hour and would be larger in the hot weather.

The number of microbes present in the air at different points were as follows:—

(1)	Opposite centre of main drain	408
(2)	Lower battlements of fort opposite commencement of main drain, wind calm	168

(3) Lower battlements of fort opposite the city, wind blowing from city 150

(4) Lower battlements of fort near south-east bastion ... 104

The estimate of purity of the air by means of iodine solution was made giving the following results :—

(1) Within five feet of the lower end of the main drain ... 46

(2) On lower battlements of fort opposite main drain ... 88

(3) „ „ facing city 118

The figures in the above table are the numbers of litres of air required to produce decolourization in the same amount of iodine solution.

S. A. HARRISS, M.B., C.M., D.P.H., D.T.M. AND H. (CAMB.),
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NOTE ON AN EXPERIMENT ON SULLAGE TREATMENT AT LUCKNOW.

By Mr. A. W. E. Standley.

The Lucknow experiments were started in 1905 in connection with the Lucknow drainage scheme. It was thought then that no proper outfall could be found for the sullage, as an intercepting sewer along the face of the river discharging well below the inhabited portion of the town was considered too costly and impracticable, and the cheaper method was said to be that of dealing with the sullage at each of the outfalls before the effluent was allowed to discharge into the river.

The location of the works was unfortunate. The Chattar Manzil Club was within a mile of it, and the Residency was close, besides there were houses not far, but on account of the situation of the main sullage drains which served the Maulvijung area no better place could be found.

In 1905, the liquifying tanks, which afterwards were turned into mere detrition pits, were built, their dimensions were 15′ × 10′ × 6′ 9″, six in number, their aggregate capacity being 37,500 gallons.

A continuous filter fed by a Fiddian distributor was also completed and started working. The diameter of the filter was 45 feet and its depth 3′ 6″, the effective filtering area was 1,550 square feet, and the filtering media Jhamu ballast. In the meantime progress had been made with the surface drain and in 1906 it was found that the Fiddian's was too small to deal with the sullage and the results were not good. In April of that year an open septic tank was added, the capacity of which was 106,250 gallons. During the same year, three sets of contact beds were built to provide extra filtration. The area of the top of the primary was 18′ 6″ × 16′ 0″, secondary 20′ 0″ × 16′ 0″, and the depth in each case 5 feet. Side slopes were 1 to 1 and the capacity of each bed was approximately 682 cubic feet. Taking the water capacity as being one-third, then the three sets could deal with 682 cubic feet or 4,263 gallons per filling. The number of fillings allowed per day was two, the period of contact being 2 hours, and of rest from 6 to 12 hours. So these filters could deal with 8,526 gallons per day when working properly. The filtering media as in the case of the Fiddian was Jhamu ballast varying in size from $2\frac{1}{2}$ to $\frac{1}{2}$ cubic inches. The liquid was left from 4 to 6 hours in the tank, the period was really too long especially in the hot weather.

About the end of November 1906, the Riful-i-Am Club complained of the smell from the septic tank, and in consequence its use was discontinued about six months afterwards; and in the meantime to increase further the filtering capacity a continuous filter with spray nozzles, 25 in number, was added; the dimensions were 40′ × 40′ or 1,600 square feet and 6 feet deep; and a few months afterwards 16 more nozzles were added making a total of 41. Further complaints about the nuisance from the smell were received, and the liquifying tanks were then abandoned as such, and were used two at a time as purely detrition pits. As soon as any gas was given off from the tanks in use, the sullage was turned into a second pair and the former pair cleaned out.

To deal with the mineral matter in suspension, a Fiddian tank was ordered as an experimental measure, and also a Scott-Moncrieff, standardizing apparatus, but these were never used, as the experiments were abandoned as soon as the intercepting sewers became practicable.

The quantity of sullage treated was 175,000 gallons in the 24 hours, the maximum rate of flow in the morning for two or three hours being at the rate of 28,000 gallons per hour. The population served was 45,669 and the area 634 acres. This gives an average flow of 4 gallons per head per day, with a maximum flow of 0·61 gallon per hour. It may be noted here that that portion of Lucknow has a piped water-supply, and that the average consumption was about 12 gallons per head per day, with a maximum average during the hot weather of about 16 gallons per head per day. The contact beds as previously stated dealt with 8,526 gallons per day in two doses thus left 166,474 gallons to the two continuous filters. Taking an average for the

day, the rate of filtration was 53 gallons per square foot per day, is 2·2 gallons per square foot per hour. This was really not a correct average, for during the period of ordinary flow there was not enough sullage to keep both filters goving and one had to be shut down. During the period of maximum flow all the filters had to deal with 28,000 gallons per hour, the contact beds took 4,263 during the first hour, so the rate of filtration for the continuous filter was 7·5 gallons per hour while the contact beds were being supplied and 8·8 gallons per square foot per hour during the remainder of the period of maximum flow.

Very few analyses of the effluent and crude sullage were made it appears before July 1907, and the reason for this was that it was intended getting a proper sewage chemist to carry out the analyses on the spot instead of the samples having to be sent to the Chemical Examiner at Agra. The Chemist however was never procured, and all the samples had to be sent to Agra.

I give below the result of three analyses of the raw sullage made prior to July 1907 :—

Composition.	First.			Second.			Third.		
	Parts per 100,000 crude sullage effluent after settlement.	Primary filter.	Second filter	Parts crude sullage.	Primary.	Secondary.	Parts crude sullage.	Primary.	Secondary.
Suspended matter	51·0	31·0	19·6	286 8	30·0	19·0	446 0	3·0	26·5
Free Ammonia	9 0	7 0	1·34	12·54	9·866	7·466	15·8	17·8	2·85
Albuminoid Ammonia . .	0·3	0·3	0·21	0·48	0·244	0 333	0·54	0·30	0·138
Nitrites	*Nil.*	*Nil.*	0 25	*Nil.*	*Nil.*	2·1	*Nil*	*Nil*	0·7
Nitric Nitrogen	1 81	3·28	4·66	5·34	1·77	1 73	Not given.		..
Oxygen absorbed in 4 hours ..	6 08	7 2	2·86	3·06	2·11	3·25	5·684	2·820	1·940

From July the analyses of the effluents were regularly taken, and as they are very numerous they have not been given. But the analyses show the effluent to have steadily deteriorated, and the contact beds get clogged by the mineral solids which the sullage contained. These beds were put out of action and thoroughly washed. On the whole the filters acted as pure mechanical filters, most of the results are bad and in nearly all of them no nitrification at all is noticeable. The two best results were for the contact beds and were as follows :—

——	Suspended matter given per 100,000	Oxygen absorbed per 100,000	Free ammonia per 100,000	Albuminoid ammonia per 100,000.	Nitric nitrogen per 100,000.	Nitrates per 100,000.
Contact filter 7th July 1907 ..	10·0	5·865	1·120	0·14	8·000	6·600
Do. 15th do.	1·5	7·154	1·920	0·13	7 200	7·700

For some reason or other these beds seem to have stopped working properly very suddenly. It may have been due to rain bringing in a lot of mineral sediments which may have clogged the surface of the filters and thus preventing free access of air, but still they were cleared out and washed, and yet the results never improved.

The results of the analyses may not have been correct, for these samples took about a week before they were analysed, and it shows that in a case of an installation of this kind, there should be a chemist at site, so that samples of the fresh effluent could be analysed at once. In some samples the analysis makes the action of the filters decidedly detrimental, for in any case more solids come out of the filters than went in, also ammonia in two cases and more albuminoid ammonia in all. It is hard that this could have been the case, unless—not likely—the sullage was

swished through the filters at a great rate. The Chemical Examiner afterwards questioned the accuracy of these results and pointed out the necessity of getting the analyses on samples freely procured.

The results from a purely experimental point of view were really a failure, and no definite conclusions as to the treatment of sullage in this particular way were derived from them. They were given up, as levels showed that two intercepting sewers along the face of the river were possible and ultimately these were built and the crude sullage was discharged by gravitation on two sullage forms. Before giving these experiments up entirely proposals were made for building proper sedimentation or settling tanks above the existing detritus pits—they were to be two in number side by side. The tanks were proposed to be 5′ × 4′ and roughly speaking 40 feet long with proper screens, scum board, baffle walls and were to be provided with sump and flush drains. At the maximum rate of flow of 28,000 gallons per hour, the rate per second would be 1·25 cusecs, and as the cross section of each tank was to be 20 square feet, the velocity of flow through them would have been $\frac{1}{16}$ foot per second, enough to deposit the lightest mineral sediments. At the daily average rate of flow, the velocity through the tank would only have been $\frac{1}{64}$ foot per second. If both tanks were to be used during the period of maximum flow, the velocity through them would have been only $\frac{1}{32}$ foot per second. It was also proposed to revive the old septic tank, but to arch it over. The tank would have been 127′ × 21′ 5″ × 6′ 9″, so that the capacity of each would have been 53,575 gallons. At the maximum rate of flow the sullage would here take two hours to pass through one. If this was not considered enough for septic action, both were to be used so that the time of flow would have occupied four hours, which generally was considered to be more than enough to set up and complete the action of the anoerovic microbes.

The rate of flow through the continuous filters was much too high. As before mentioned the rate of filtration was from 7·5 to 8·8 gallons per square foot per hour, at the time of maximum flow of sullage, this means a maximum rate of filtration of 1,900 gallons per square yard in the 24 hours. The rate allowed should have been about 2 gallons per square foot per hour, but it would have meant providing four times the area of filtration.

The Fiddian too was only 3′ 6″ deep and it should have been 6 feet at least, and probably its conversion into a spring filter would have been better. The continuous filters might have been long and narrow without masonry side walls, so that air might have been admitted to all parts of the filtering material and thus offer favourable condition for the vigorous action of aerobic microbes.

The experiments do not prove the impossibility of treating sullage like crude sewage, but it does show the very great difficulties of getting rid of the mineral matter which comes into the drain with the sullage, this unless completely removed clogs or will, in a short time, clog any filter, and continual working of filters is a matter of cost. Unless surplus filtering area is provided, there is great difficulty in working the filters, and these as well as the provision of large and suitable sedimentation tank absorb a good deal of expenditure. The rate of filtration too has to be regulated to the maximum period of flow and kept down to very much less than what it was, viz., 7·5 to 8·8 gallons per hour, and unless we have large storage tanks to store the sullage during that maximum flow we could not get the necessary maximum rate of filtration which probably should not be more than 2 gallons per square foot per hour. The storage tanks might be septic tanks themselves, but with a climate like India unless they are covered in and out of the way, the nuisance from them is unbearable, for decomposed sullage is much worse than proper sewage in that respect, and large covered tanks mean money. Unless conditions are absolutely impossible, the conclusions seem apparent, in any case put the crude sullage as it comes from the drains on to the ground, the climate and soil of India are all in favour of this move. And in the long run, the method is the cheapest although the capital outlay may be slightly higher at first. A sullage farm like the one at Agra will become a source of revenue, whilst any purifying installation is a source of yearly recurring expenditure to keep it in working order, for it must necessarily mean trained establishment to work and look after it. Besides, constant examination of the fresh affluent must be made and this ought to be analysed locally, a condition which is very difficult to obtain in India at present.

IS IT RIGHT TO RECLAIM LOW-LYING LANDS AND SWAMPS WITH REFUSE IN A CROWDED CITY?

By Dr. D. B. Master.

Perhaps the ultimate object of this short paper will be better understood, if I prefaced it by at once acknowledging, that in reading it before this conference, I wish to start a broad discussion of this important sanitary question from various points of view, so as to give full scope to divergent opinions, more especially from its so-called utilitarian and economic, as against its health and vital aspects. The discussion will, I hope, elicit and possibly lead to an expression of opinion against the wisdom of the policy of filling in the low-lying lands and swamps of a city, with what is known on our side of the country as "kutchra" or street refuse. Such an opinion would be very valuable, coming as it would from such an important body as this Sanitary Conference, specially created to discuss and advise on matters sanitary. It would, in fact, come to be considered more or less an authoritative pronouncement, and lead to the adoption of a definite line of action in the future, by all Indian Municipal Administrations. With this brief preamble I will proceed with the subject proper.

1. It is hardly necessary to say that the chief object with which all sanitary measures are undertaken and enforced by law, in all civilized countries, is to keep air, water and soil in as pure a state as possible. With this object in view, a very large annual expenditure is incurred, as far as their means will permit, by all the municipalities and Local Boards in India.

On economic grounds it has often been alleged, that the cost of filling in the low-lying lands and swamps in a city with sweet earth, becomes so prohibitive, that even rich Municipalities cannot undertake it. If, on the other hand, the swamps are left untouched and not reclaimed by refuse on sanitary grounds, water collects in them during the rains, and they eventually become a prolific source of mosquito breeding, leading to a large prevalence of malaria in the surrounding localities. Both these arguments are possibly sound. But when we take into consideration the ill-health, the inconvenience, and the danger of spreading diseases and even death in the surrounding population, through the agency of flies, which breed in enormous numbers in the refuse, the so-called economy and the saving of money dwindle down considerably.

It is well known that offensive emanations and products of putrid or stagnating material, contain various kinds of disease germs in enormous numbers, and they not only serve as so many direct sources of infection, but also help in greatly lowering the vitality of the people, giving rise to various gastric or intestinal disturbances in susceptible persons, and thus reducing their earning capacity. So that what the Sanitary Authorities save from their coffers in reclaiming land by refuse, is paid tenfold by the people in the sacrifice of their health and earnings, and even their lives at times.

The recent experience of the city of Bombay, soon after the last monsoon, has shown how very badly people suffered from the pest of flies created by the dumping of refuse to fill in certain swamps in the northern part of the city. And it is not at all surprising. It has been ascertained that a single fly lays 120 eggs every fortnight, and by successive generation breeds millions and trillions of flies within three or four months. From this it will be readily seen what an enormous number could be brought into existence when such "breeding farms" are brought into existence by the dumping of refuse in the midst of a city. When this subject was being discussed at one of the meetings of the Bombay Municipal Corporation, a short time ago, a well known councillor gave it as his personal experience that his house was so badly inundated by an enormous number of flies during the day and mosquitoes by night, that he had literally to fly from his bungalow, while the operations of reclaiming some of the swamps by refuse was going on, and put up for the time being in another part of the

city. Of course he was a well-to-do gentleman and he could afford to leave his bungalow, and go elsewhere. But every one cannot afford to do so, and the majority of those living around had to put up with the great inconvenience, and constant annoyance that these house-flies caused.

Owing possibly to this dumping of refuse in the low lying grounds, the nuisance of mosquitoes, soon after the rains this year, was also considerably greater than in any previous year, as was testified by several speakers at the same meeting. The Municipal Commissioner, however, controverted it by saying that the abnormal increase of mosquitoes had nothing to do with the refuse, as the mosquitoes do not generally breed in "Katchra" but in collections of water. The Commissioner was right in saying so, as far as our present knowledge regarding the development of mosquitoes goes. It has been stated by well known authorities that mosquitoes as a rule develop in clean waters. But our Bombay experience tells us otherwise. Mosquito larvæ have been generally found in wells whose waters were, after a careful laboratory examination, pronounced to be foul and contaminated by sewage matter, by the Health Department. It is quite likely, therefore, that mosquitoes may have bred and developed in much larger numbers than before, by the fouling of the rain water, collected in the swamps, by the refuse that was dumped in them, thus affording a more suitable nidus for their breeding.

In the Health Officer's own reports it was also stated that mosquitoes are sometimes found in some of the gully-traps, and in the storm-water catch pits. The water that collects in them is very badly contaminated by filth of various kinds which more or less stagnates and decomposes, and the water is thus rendered foul. And yet mosquitoes are found there in large numbers, foul matters notwithstanding.

2. We shall now consider the question of the *cost of reclaiming swamps and low-lying lands with sweet earth.* Taking only a very recent instance the cost of filling in the Gawalia tank, one of the largest tanks in the city of Bombay, has come to about Rs. 7 per yard. If we take that as also the probable cost of filling in the low-lying land on the flats, it cannot be considered to be quite prohibitive, more especially if we take into consideration the fact of the amount of injury that is likely to be caused to the public health, by reclaiming it with refuse. The land thus reclaimed cannot be of any use for residential purposes for at least thirty or forty years, and must of necessity remain idle and useless for at least that length of time. On the other hand, land reclaimed with sweet earth, will fetch almost the same price per yard as the cost of filling it in, because the price of land in Bombay is daily increasing. Even if it fetches a few thousand rupees less than the actual cost incurred, that should not be taken as a great loss by any means, looking to the amount of good that would be done to the city, and the misery, inconvenience and ill-health that would be avoided, but which would otherwise be brought in the wake of the other insanitary measure.

However great the initial cost of some of these sanitary measures, it is repaid literally a hundredfold by the great improvement in public health, in the long run. I will at once admit that the cost of reclaiming the low-lying lands in a city by earth would be enormous. But when, in our city of Bombay for instance, we are prepared to spend nearly fifty lakhs of rupees on constructing a big road, the one which would be known as the Eastern Avenue, for the improvement of the health of the people, besides the two or three crores that we have already spent in carrying out improvement schemes in other directions, and when we intend to spend yet several crores of rupees more on reclaiming land even from the sea, I think we should not grudge to spend a few lakhs over reclaiming these disease-generating swamps. If the present generation is not able to bear this large burden, the Municipality of Bombay should, in my humble opinion, apply to Government for a special large loan extending over 60 or 80 years for repayment.

It is not right that while trying to improve the city in one direction, we should deteriorate it in another by such cheap but wrong and injurious measures. We have already had a very bitter experience of this policy of filling in the low-lying lands by refuse, in the ill-health created by the reclamation of what were known as the "Byculla Flats" in the past, and some of the older residents, who had lived round those flats, can well enlighten the authorities as regards their sad experiences of those olden days. I may explain here that the Municipal

Corporation of Bombay had passed in previous years a special resolution prohibiting the dumping of refuse on low-lying lands in the city. But the recent scare of malaria has made them quietly acquiesce, so to say, in the setting aside of that resolution by the municipal executive, on the grounds of economy and practical utility.

I do not for a moment blame the Health Officer, or the municipal executive, or even the Corporation for this sliding back into the old policy. I know they have re-adopted it with the best of intentions, in order to do away with the great nuisance of the swamps and the breeding of mosquitoes, as cheaply as possible. But I cannot help saying, that in their zeal to choose between the two evils, they have thought more about rupees, annas and pies than the health of the people. What is cheap at present will, I am afraid, be very dear in the future.

In this connection let me quote here the words of Dr. Parkes, an eminent authority on sanitation: "It has been proved over and over again that nothing is "so costly as disease, and that nothing is so remunerative as the outlay which aug-"ments health, and in doing so augments the amount and value of the work done." These wise words were written some forty years ago, when sanitation had not made so much progress as at present, and when people did not appreciate the benefits of different sanitary measures so well as they do now, with the spread of education. Those words are as true now as they were then.

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

NOTE ON A COLOMBO REFUSE DESTRUCTOR,

BY

C. L. COX, ESQ.,

City Sanitation Engineer, Colombo.

House rubbish in Colombo is collected in portable sanitary rubbish bins, the use of which is enforced throughout the City, and, together with street refuse, is removed in specially designed self-clearing single bullock carts.

2. Owing to difficulty in obtaining suitable sites, trouble in securing an efficient transport service and the sanitary objections against refuse dumping in the vicinity of the City, the Municipal Council have established a Refuse Destructor.

3. The following description of the plant and its method of operation is derived from particulars kindly supplied by the Works Engineer.

The plant is of the Horsfall Back feed continuous grate type with six cells designed to dispose of 10 tons each per 24 hours. The Hot Air blast to the furnaces is supplied by two Roots blowers drawing air through Regenerative Air Heater from the intake over the rubbish delivery hoppers. The plant includes a Babcock and Wilcox boiler, an auxiliary oil engine for the blowers, two beast cremating chambers and a dust catcher of the Accrington Patent Type.

A feature of the plant is the additional oil fuel heating apparatus for use with wet rubbish. The oil is atomized by super heated steam and, mixed with air, is ejected into the furnaces through spraying nozzles.

The refuse delivery hopper has a storage capacity of 30 tons. The back is loped to deliver the refuse to the feeding floors, and the openings through which the refuse is tipped are closed with balanced doors.

The plant has been in satisfactory operation since the beginning of the year and the following notes may be of interest.

The rubbish contains a large proportion of sand and mineral matter. In wet weather it is 25 per cent heavier than in dry. The capacity of the plant varies from 45 tons per diem in wet weather to 75 tons per diem in dry.

The cost of destruction, including all charges except amortization and the cost of liquid fuel for the auxiliary burners, varies between Rs. 1-30 cents and Rs. 1-50 cents per ton. A saving of 16 per cent in rubbish transport charges has been effected by the use of the Destructor. The furnace residue which consists of broken bricks, tiles, sand, fine ash and friable clinker, amounts to about 40 per cent by weight of the rubbish burnt. Except as filling the furnace, residue would appear to be useless, but the fine ashes are being tried on Cocoanut Estates and the dust from the flues and combustion chamber is stated to possess some value as a fertilizer for use on local paddy fields.

In the initial stages some trouble was caused by the accumulation of fine dust in the flues and regenerator, but this has been obviated by providing additional access and clearing openings.

The oil jets are not entirely satisfactory and the benefit derived from their use does not correspond with the heavy expenditure of fuel. The defect is attributed to the fact that the flames do not properly impinge upon the rubbish.

PART VII.

PROBLEMS CONNECTED WITH THE MILK SUPPLY.

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

THE UTILISATION OF A CONTINUOUS TEMPERATURE OF 50° C. FOR THE PRESERVATION OF THE POTABILITY OF MILK.

BY

Military Assistant Surgeon G. Mackey, I.S.M.D., Assistant to Director, Central Research Institute, Kasauli.

The preparation of milk for preservation and the milk when so prepared, is a subject of the utmost importance to any community that values its child lives—and what community does not. In India the question assumes an importance greater than in European countries owing to the greater facilities for contamination of milk and the aid which high temperature conditions give to the multiplication of specific contaminations. The preparation of milk for preservation refers to such treatment as will prevent the growth of bacteria in it, or will get rid of them altogether. The process is one of sterilisation and it may be partial or complete. The ideal method of treatment would consist in complete sterilisation, but the objection to this lies in the fact that it cannot be effected without materially altering the taste and chemical constitution of the milk. We seek therefore to find a method which shall cause the disappearance of such disease producing germs as those of tuberculosis, typhoid fever, diphtheria, dysentery, cholera and Malta fever with the least possible alteration in the qualities of the milk. The method to which I refer in this note as giving this result is a certain degree of heat sterilisation by heat. A favourite mode of obtaining this is by what is called Pasteurization after Pasteur who used it for sterilizing wine and beer. It consists in raising the milk to a temperature of 60°—65°C for a variable length of time, usually 20 to 30 minutes. Such temperatures applied for such intervals of time will cause the disappearance of disease producing germs. They will not however cause the disappearance of all bacteria from milk. As there is some evidence for believing that intestinal disturbance in children is associated with the presence of unduly large numbers of bacteria in milk whether definitely known to be disease producing or not it is necessary to combine with any partial sterilization process a method of preservation also if the milk is to remain a safe food for infants. Such would be the case when milk has to be kept for some time before use. I have been experimenting on the reduction of the bacterial content of milk with a view to determining under precise conditions, at what point reduction is brought about and also with a view to laying down what is the simplest procedure to adopt for the preservation of the potability of milk in a stationary household. Figures referring to thermal death points are given in all books which treat of this subject, but these are more often given as isolated data rather than as a series in which the interrelations of time and temperature are taken into account. Thus although we find a division made between "flash" and "holder" methods of Pasteurization, there are no very satisfactory tables published which show what is the difference in effect between a non-incubating temperature, an incubating temperature and a sterilisation temperature, maintained for varying lengths of time upon the bacterial content of milk. The transition between these temperatures is a gradual one and it has been my endeavour to trace the course of that transition.

Whatever be the process of preparation or preservation of milk, it is essential that all possible cleanliness should be observed in all the operations concerned. As a preliminary to the experiment which I am about to detail, I had the hands of the milk woman washed with soap and water and the udders of the cow likewise. The pan into which the milking was done was cleaned by scrubbing with soap and water and then washed out with boiling water. Samples of the milk were placed in sterile test tubes plugged with cotton wool and these set into water baths at special temperatures. The temperatures used were cold storage (6—7°C), room temperature (20—24°C), 30°, 40°, 50°, 60°, 70°, 80°, and 90°C. Measured quantities of these samples were removed at stated intervals for examination of bacterial content. Dilutions of these quantities had to be made at

certain times in the experiment—notably at 6 hours and 8 hours for the samples exposed to temperatures of 30°C and 40°C in order to obtain satisfactory enumerations of the bacteria. The method of enumeration was by planting on a solid Agar medium and counting the colonies which resulted after incubation for 3 days at 37°C. The use of another medium and incubation at another temperature would doubtless have given somewhat different results, as it is well known that many organisms which develop at 22°C will not develop at 37°C. These results however are comparable with one another. The following table gives the facts in concise form and is a record of but one of several similar experiments all of which gave analogous findings.

TABLE I.

Showing the number of bacteria per c. c. of samples of milk kept at varying temperatures for varying times—

Temperature centigrade at which milk was kept.

No. of hours at given temperature.	C. S.*	R. T.†	30	40	50	60	70	80	90
0	3600	3600	3600	3600	3600	3600	3600	3600	3600
½	—	3800	3000	2800	800	0	0	0	0
1	1500	1700	2700	2000	500	0	0	0	0
2	900	1800	3100	2600	200	100	0	0	0
4	1400	1500	5000	7000	0	0	0	0	0
6	1600	1600	50,000	20,000	0	100	0	0	0
8	1300	2100	630,000	340,000	0	0	0	0	0

* C. S.= Cold Storage. † R. T.= Room Temperature.

hours.

0.	½.	1.	2.	4.	6.	8.
6°	6 2°	6·5°	6·5°	7°	7°	7°

Temperatures.

hours.

0.	½.	1.	2.	4.	6.	8.
20·5°	22°	22·9°	23·0	24°	24·5°	24·9°

Temperatures.

We may make certain deductions from this table—deductions which may not unreasonably be extended to cases in which the conditions are similar as regards time and temperature. (1) Little or no change occurs in the bacterial content of milk kept at cold storage and room temperatures such as are given here up to 8 hours. A certain amount of apparent diminution of the bacterial content of milk takes place in the first hour or two of subjection to any temperature, whether subsequent increase occurs or not. This is a phenomenon which is well known and has been variously interpreted.

(2) At what may be called incubation temperature, 30° and 40°C, increase in bacterial content is not manifest until the 4th hour but after that proceeds apace.

(3) At 50°C we enter upon the sterilisation phase. A steady diminution in the bacterial content is shown from the commencement of operations, and no colonies on Agar develop from the sowings at and after the 4th hour.

(4) At 60°C sterilisation is still more manifest than at 50°C and so progressively at the higher temperatures.

The difference between temperatures of 30° and 40°C is interesting as showing that while the temperature of 40°C was an incubating one and promoted multiplication, it was not so to the same extent as that of 30°C. There is either a certain

death-rate to be taken into account at 40°C or a greater death-rate than at 30° C. But the most interesting temperature from the point of view of recommendation for home sterilisation is that of 50°C. This is much below Pasteurization Temperature and yet we see that from the beginning no increase in bacterial content took place but only continuous diminution. My suggestion is that it would be easy to raise milk to this temperature and to keep it there. If thought to be necessary it would be easy to take milk up to a higher temperature and then allow a fall to 50°C (122°F.) which temperature could be then maintained. The method should prove useful in cases where milk in bulk has to be kept for any length of time and would be much easier to carry out in a stationary household than preservation at non-incubating temperatures. The apparatus used would be very simple—a tin receptacle for the milk with cover and aperture for thermometer, a stand for the same and a small kerosine oil lamp. The entire outfit, with the exception of the thermometer, could be procured in any ordinary bazaar. If desired milk could be filled into feeding bottles which could be stood in water in the receptacle and maintained at this temperature of 50°C (122°F.). As milk is usually given to infants at body temperature, it would be easy to cool down from 50°C to this temperature—much easier than to set to work and bring up the temperature of milk kept, to preserve it, in a cool place. I feel therefore that in recommending this procedure to notice, I am recommending one which is simple and would in many households afford a satisfactory solution of a difficulty—the preservation of the milk supply in hot weather without ice. Various modifications of the method will naturally suggest themselves, as for instance the use of thermos flasks to preserve the necessary temperature. In the use of these however care must be taken that the temperature shall not fall from a sterilising to an incubation temperature. Where a milk supply has to be procured for a journey the method suggested here will not have any special advantage, particularly if the journey be a long one. Indeed in that case it could scarcely be carried out as maintenance at the temperature of 50°C becomes almost an impossibility. In such a case completely sterilised milk becomes a necessity. These milks are supplied commercially. They must necessarily be altered in taste and composition as the temperatures used in their preparation are higher. The following table gives one an idea of what is needful in order to completely sterilise milk. The test used for sterility was the absence of clotting of milk incubated at 37°C for ten days; after it had been subjected to varying temperatures for varying times. The entries in the columns and rows of table 2 show approximately the number of hours of incubation before clotting was visible. The clotting is of course due to bacterial action and implies that all bacteria were not killed by the procedure adopted.

TABLE II.

Showing the number of hours before clotting became evident in milk, which after having been subjected to varying temperatures for varying times was placed in an Incubator at 37°C.

Temperature centigrade to which milk was subjected.

No. of hours at given Temperature.	70	75	80	85	90	93	
1	52	52	52	52	64	—	The dashes in this table signify that clotting did not take place at all in the ten days of experiment. The same milk kept simply at room temperature throughout clotted in 72 hours: placed directly in the incubator after milking, clotted after 32 hours, and placed in cold storage directly after milking did not clot at all in the time.
3	37	37	37	49	—	—	
5	59	59	59	73	—	—	
7	56·5	56·5	56·5	—	—	—	
9	55	55	82	—	—	—	
11	51	63	—	—	—	—	

At the altitude of Kasauli (6,000 feet) 93°C is boiling Temperature.

An interesting feature of this series of experiments is that clotting appeared earlier in milk subjected for 3 hours to temperatures of 70°C and above, than when subjected for only 1 hour at these temperatures. It is evident from the table that prolonged heating, even at a temperature of 85°C, is necessary to complete the sterilisation of milk. I am continuing experiments such as those detailed here with the idea of obtaining data for use in connection with the preservation and satisfactory use of milk, and also of investigating the bacteriology of Indian milk.

My grateful thanks are due to Major W. F. Harvey, I.M.S., Director, Central Research Institute, for his kind help and advice throughout this investigation and also for his initiation of the same.

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

MILK SUPPLY OF CALCUTTA.

BY

Rai Kailas Chandra Bose Bahadur, C.I.E., L.M.S.

In a populous city like Calcutta where nearly one-third of its inhabitants are vegetarians, where the majority of its half-starved Indian mothers have to resort to artificial feeding in rearing up their infants, where the educated class so frequently suffer from Diabetis Mellitus, where the number of its sick is always pretty large, the necessity of an adequate supply of pure milk and milk products is a question of vital importance. But under the existing circumstances pure milk is considered a costly luxury which is almost inaccessible to the poorer classes. The supply in Calcutta falls considerably short of its actual requirements and the bulk of it comes from outside the city and from distant villages. When the sources of supply are numerous and almost indefinite, it would be idle to expect anything radical to be done to prevent adulteration of milk; and unless we can do it we must always be prepared to meet with periodic outbreaks of disease introduced into our city through the agency of contaminated milk. At present milk is daily brought into our city by itinerant gowalas from the suburbs by country boats from the adjoining villages and by rail from diverse parts of the province of Bengal, and the time of the journey by rail ranges between 2 and 4 hours. To offer facilities to the traders of milk, the railway authorities have provided them with special vans which bring daily over six hundred maunds of milk into the Calcutta markets. The milk after its arrival in Calcutta is taken to the stalls where it is sold to the best advantage of the vendors. There are several distributing centres in the Northern division of the city, amongst which Boytuk-khana, Jorasanko and Sova Bazar occupy a prominent place. Milk in any quantity can be had in these markets both day and night. In addition to these markets there are numerous other stalls and shops where boiled milk, butter, curd cheese and other preparations of milk are sold to customers. The demands of the Southern division of the city are met by stalls kept at the Municipal market, Bow Bazar and Bhowanipur. The consumption of milk amongst Europeans and the better class of Eurasians is indeed very small and they are particularly cautious about their supply; they must either get it from the Sir Stuart Hogg market where milk is sold under the strict supervision of the Health Department, or have it drawn from a healthy cow at their own places. There is no control over milk which comes from outside the town. The food inspectors whose number is limited, cannot possibly manage to examine every sample which is brought into Calcutta; nor is the Health Officer vested with power to inspect cattle sheds and dairy farms which lie outside the precincts controlled by the Calcutta Corporation. Before its transit to the Calcutta market, milk is collected from various sources and the gowalas who are not concerned with the effects of stale and bad milk upon the health of its consumers, do not hesitate to adulterate it to a mischievous extent. I need hardly mention that the gowalas belong to an unscrupulous batch of milk dealers whose sense of responsibility is almost *nil* and that they are quite capable of doing anything to promote their own interests at the cost of the health and life of their customers. It is a matter very much to be regretted that we cannot possibly prevent the importation of milk into the city but as I have said before, the local production is insufficient to meet the demands of

Calcutta. The table which I give below will I doubt not bear me out in my view.

Wards.	Number of cowsheds.	Number of cows sanctioned.	Population.	Daily yield.	Quantity available per head.
1	46	731	52,994	1,462	·0275
2	7	86	33,065	172	·0052
3	33	489	54,606	978	·0179
4	11	174	48,160	348	·0072
5	2	24	53,346	48	·0008
6	10	135	59,462	270	·0045
7	1	4	31,529	8	·0002
8	6	36	57,188	72	·0012
9	3	21	64,793	42	·0006
10	7	49	25,017	98	·0039
11	10	24	29,961	48	·0039
12	*Nil*	...	6,074	...	...
13	1	11	28,485	22	·0007
14	9	35	32,180	70	·0021
15	11	102	11,811	204	·0172
16	...	...	...	...	...
17	...	...	...	...	...
18	2	20	4,241	40	·0094
19	4	120	43,821	240	·0054
20	2	156	43,421	312	·0071
21	10	143	34,897	286	·0081
22	5	26	54,713	52	·0009
23	6	61	20,322	122	·0060
24	1	6	21,764	12	·0005
25	4	23	4,386	56	·0125

As we cannot under the existing arrangement of things altogether do away with the importation of milk into Calcutta and as adulteration cannot be completely prevented, we can only resign ourselves to our fate and leave the safety of our infants to the Will of the all-merciful God.

Now let us see whether the inconsiderable quantity that we get from the dairies of Calcutta is free from contamination. The prosecutions and impositions of fines which so frequently occur, show that we have not succeeded in preventing the adulteration of milk in Calcutta. Recently the Calcutta Corporation appointed a committee to investigate the circumstances which lead to the adulteration of milk and to suggest measures to remove them effectually. As a member of this committee, I visited several cow sheds and was surprised to find that in spite of all the vigilance of the Health Department the gowalas kept their cattle-sheds and cows in a most disgraceful condition. I would with your permission try to give the Conference an idea of the insanitary condition under which they are generally kept. The flooring of the sheds in most cases was covered with a thick layer of excreta from animals which were huddled together with scarcely any intervening space between them. Their udders and teats were

thickly coated with dung and mud. There were only two or three calves in a shed kept for show, the rest having been disposed of within a fortnight after their birth. The gowalas keep the secretion of milk intact by adopting an unnatural process which soon renders the animal unfit for further service as a milch cow. The milkers generally belong to a low class Oryas who defy all rules of sanitation, whose hands are covered with filth and whose dirty clothes contain microbes of diverse species. There is no separate place for storing milk, and the milkers generally collect their milk in unclean brass lotas which when filled are emptied into open tin receptacles specially reserved for the storage of milk; hundreds of dead flies are found floating on the surface of the milk. In one instance a pup was found drinking milk from a vessel in which a measured quantity of milk was kept ready for transit to the house of a neighbouring customer. In some of the sheds the flooring was pucca with special arrangements for the immediate disposal of dung and urine, but the number of such sheds was few. In none of the sheds of Calcutta did we find any restriction as to numbers of animals. Cleanliness as a rule was wanting. I need hardly mention that the hairy coat of the animals harbours dirt and germs to a fearful extent. The sheds situated in the fringe area of the town were in most cases supplied with tank water. In Entally which is a suburb of Calcutta chiefly inhabited by Eurasians, there exists a big dairy form managed by a Eurasian gentleman who resides within the compound. Here I was delighted to find that the cattle were placed under the best hygienic conditions and every facility was given for their free movement. They looked healthy but the herd was not altogether free from tuberculosis. Veterinary Assistant Surgeon Bose in carrying out tuberculin experiments, under the orders of the Principal of the Bengal Veterinary College, mentioned that he had discovered two infected out of a batch of 30 cows. As the time of my visit was not milking time I did not see how it was actually done there. Four milkers were produced before me and although they were not cleanly dressed, still they said they washed their hands before touching the cow, but unfortunately one of them was suffering from Phthisis. There was no arrangement for examining the teats and udders of the animals. There was a tank, not over fifty feet distant from the shed, and the proprietor gave his assurance that he used it for washing utensils and other articles. There were special carts to hold milk bottles which were served out to customers. The proprietor was pleased to call my attention to the existence of a sterilizer in which he sterilized the milk before it was bottled for transit to the customers. To his regret he said that it was out of use for a few days as it was out of order. This was indeed a model cowshed. But the proprietor should know that the use of tank water even for washing purposes is a fertile source of contamination of his milk and milk products.

After having given an outline of the insanitary condition of the cows and their sheds, I would now attempt to describe the sources of pollution of milk during its transit from the shed to the stall and from the stall to the consumer. Milk after its collection is placed in big open tin receptacles, about 30" in depth with a diameter of 18" and capable of holding several gallons. They are carried by servants to the depôts and to prevent splashing and tilting up of its contents they put straws and date palm leaves within them. There is no provision to guard against the ingress of dust. On reaching their destination the milk is poured into big hundies or earthen pots and exposed for sale to customers. The mere fact of using milk after it has been thoroughly boiled does not imply that all danger of contamination is over; the vessel into which milk is at first received before putting into the can soon becomes a source of contamination. I have on more than one occasion successfully traced the outbreak of cholera to this source. Dr. Keneth McLeod in his interesting address on milk has mentioned cases of cholera resulting from the use of contaminated milk. Professor W. J. Simpson than whom no better sanitarian has ever come to Calcutta, mentioned an instance in which 10 sailors belonging to the vessel "Ardenelutha" were seized with cholera of whom 4 died, and the cause was successfully traced to milk supplied to the ship by a local vendor.

An epidemic of cholera broke out in the Gaya jail and the source was traced to the use of contaminated milk. Of all the milk-borne diseases none is held with so much horror as tuberculosis. Its access into the houses of people through the agency of milk is well known and the presence of tuberculous cows

amongst milch cows is not uncommon in Calcutta. It may be said that under the existing arrangement of cowsheds, the chance of spread of tuberculosis from one sick animal to the rest of the herd is great. Tuberculous disease does not necessarily mean phthisis or disease of the mesenteric glands; it also includes tuberculous diseases of bones and joints. It may also be mentioned here that as the species of Bengal cows is gradually diminishing, the gowalas to keep their business intact have been obliged to import cows from Multan, Hissar, Rajputana and Bhawulpore into the Calcutta market. These imported animals are more susceptible to tuberculosis than those which are procurable from the local market. The reason is quite obvious: they were never kept confined to one place and always enjoyed pure air before they were sent down to Calcutta. The abrupt change of environment and their confinement in congested cowsheds seriously tells upon their health and renders them susceptible to various diseases, amongst which tuberculosis and rinderpest are most prominent.

The secretion of milk is stopped in animals suffering from rinderpest whilst in tuberculosis it continues till only a few weeks before death. Diarrhœa and dysentery in epidemic forms have sometimes been traced to the use of contaminated milk. Infants often suffer from enteritis and thrush from the use of impure milk. Foot and mouth disease was occasionally noticed to spring from milk drawn from a cow suffering from the early stage of the disease An interesting paper on this subject was read by Dr. P. D. Bose before the Calcutta Medical Society. The quantity and quality of milk is mainly dependent on the condition of health of the animal, on the kind of food it gets, and on the environment under which it lives. A cow which gives ten seers of milk at Multan will only give four when confined in a crowded shed. The quality of milk also deteriorates. In this part of the country people resort to various methods of feeding for the purpose of increasing the quantity of milk and they often succeed in doing it. Broken rice grains boiled in water, decoction of *Amarantus Spinosos* (Kanta nutia) boiled *Lagenaria vulgaris* (white pumpkin) and boiled *Phaseolus roxburghii* (a kind of pulse known as mashkoli) are generally used for the purpose. Large quantities of water and salt are frequently given by gowalas to promote the secretion of milk. The age of the cow has its influence upon the quantity of her milk; and old cows generally give an inferior quality. I have also noticed that the quality of milk varies during different times of the day. The morning milk is slightly thinner than the evening milk. The Multani cows give more milk than the Hissar and the Hissar more than other breeds of cows. One English cow is equivalent to two Multani and three Hissar cows. I would close with a few proposals for increasing the quantity of town supplies and protecting the milk against contamination.

To achieve success nothing would be better than for Government to improve the Food Act which as it at present stands is very defective. In fact it countenances adulteration and suggests loopholes for the escape of the delinquents. People should be instructed as to the dangers of impure milk especially in connection with tuberculosis. The municipal bodies of the suburbs and villages should be vested with power to grant licenses to cattle sheds with restrictions as to overcrowding; each municipality should have its own veterinary assistant to isolate the sick from the healthy cows; and no milk should be exported without his sanction. The slaughter of prime cows should be prevented by legislature. A commission should be appointed to enquire into the causes of the scarcity of milk in Calcutta and to advise how best to save prime cows without causing agitation of any kind. Sheds should be erected on hygienic principles and the floor space should be regulated according to the size of the cows for whose accommodation they are intended—as a rule fifty feet floor space should be given to a full size cow. Feeding troughs should be made of enamelled iron. The floor should not be slippery but should be made of some impermeable material. The animals and the floor of the sheds should be washed with filtered water. There should be a separate place for milking cows. The milkers should be well trained men. Special glazed receptacles should be provided for collecting milk and the milk should be stored in rooms specially prepared for the purpose. The food stuffs intended for milk cows should be of the very best kind. The shed should be under the direct

supervision of the veterinary assistants, who should be responsible for their sanitation. The penalty for adulteration of milk should be a heavy one. The Health Officer of Calcutta should be authorised to inspect all dairies and cattle sheds from which milk is imported into the town. Samples should be taken from railway vans for bacteriological examination. The municipality should be requested to prepare model plans for the erection of cow sheds. No shed should be erected near a well or a tank. Special arrangements should be made for the housing, grooming and grazing of dry cows. Tuberculous cows should be immediately removed after detection of the disease, and vaccination against tuberculosis should be resorted to as a means of warding off the disease. The question of altering the existing sheds and bringing them into conformity with the requirements of the time requires careful consideration and I hope and trust the scheme now being considered by the Hon'ble Mr. Maddox, the Chairman of the Calcutta Corporation will, when brought into operation, remove many of the prevailing defects. With the improvement of the condition of the milk the milk products will naturally improve themselves and I do not think separate arrangement is necessary for them.

NOTE ON THE MILK SUPPLY OF TOWNS BY MAJOR S. A. HARRIS, I.M.S.

That some measures are urgently needed to control the milk supply of towns can be gathered from the following report by the Municipal Secretary, Lucknow:—

"I proceeded down a narrow paved lane and came to a bricked yard or open "square which is municipal property. I found that this had been thatched over, "that nineteen buffaloes were kept in this area. Heaps of rotting manure were stocked "on one side of the square, the floor was covered to a foot or more with dung. The "drains were blocked with it and the stench was abominable. In charge of these "cattle were two lepers, one with no fingers and simply able to feed the animals and "the other with only stumps of fingers left, but probably sufficient to allow him to "milk the cows."

Milk is the agent for the spread of four principal diseases—

(1) Tuberculosis.
(2) Cholera.
(3) Typhoid.
(4) Summer diarrhœa of infants and diarrhœa in adults.

The first disease tuberculosis spreads from the cattle either through the udder direct or from the udder soiled with dung contaminated with tubercle which has been passed out of the intestines.

The second and third diseases cholera and typhoid spread either from the hands of the milkmen who may be typhoid or cholera carriers, or by adulteration with infected water in transit to the consumer.

The fourth class of disease (summer diarrhœa and diarrhœa) is usually carried by flies into milk carelessly kept uncovered in the homes of the consumers, or by exposure to deleterious gases from decomposing matter or excreta. There are therefore two main lines along which action may be taken.

The first is the provision of healthy cattle and the stabling in healthy surroundings. The second is the supervision of the actual milkmen, and the transit of milk to the consumer.

With reference to the first line of action, the Agricultural Department are taking up the question of tuberculosis in cattle. During the ensuing cold weather arrangements are being made by Mr. Oliver, Superintendent of the Veterinary Department, to inspect all the milch cattle and cattle for slaughter in Cawnpore, 3 per cent. of the latter having been found to be tuberculous. This action is undertaken purely to ascertain if bovine tuberculosis is common in India.

The Royal Commission on Tuberculosis in their report state that not only can tubercle be carried into milk through the udder but it can also be introduced by contamination from infected dung and dirty udders. The measures taken to provide milch kine with good stables and sanitary surroundings may be either (*a*) repressive or (*b*) constructive—(*a*) repressive, in that the smaller gwalas are eliminated by enforcing stringent by-laws for byre construction and encouraging the richer owner to build large dairies, or (*b*) constructive, by the retention of the smaller gwala but compelling him to keep his cows in model byres. This is a method adopted in Bombay.

Dairies can be situated in three positions.—

(*A*) The model dairy or byres in each mohalla or quarter of the towns,

(*B*) Model dairies situated in the outskirts of towns and cities, and

(*C*) Model dairies along the railway line within a reasonable distance of the city.

(A) The advantages claimed by the model mohalla dairies are that,

(*a*) they would be under constant supervision,

(*b*) that the milk would not have far to travel to the consumer,

(*c*) that if adulterated with water, tap water would be used, in place of possibly cholera or enteric infected water from pools or wells outside the city, and

(*d*) the milkmen if enteric carriers could be eliminated.

The objections to these methods are—

(*a*) *The difficulty of access to grazing grounds or to fields for the exercise of the cattle.*—In Lucknow the land in the vicinity of the town is very valuable and is under heavy cultivation. Most of the cows in the city are stall-fed. It is proposed that the sullage farms should be placed under the direction of the Agricultural Department for the cultivation principally of guinea, chari and luceren grass and other fodder crops for the milch cows. In other towns it may be possible to obtain grazing grounds in the vicinity of the city to which the herds might be driven. Against this is urged: the foul foods that cows pick up along dirty lanes when proceeding in and out of the city, and the possibilities of outbreaks of disease in the herding of large number of cattle together which might wipe out to a large extent the animals producing the milk supply of the city.

(*b*) The second objection to mohalla dairies is the cost of land acquisition for the site and the expense of building model dairies.

(B) For dairies in the vicinity of the town the advantages claimed are—

(*a*) good grazing grounds,

(*b*) no fouling of the streets by cow-dung, nor necessity for the removal of litter and dung from the byres by the municipal conservancy.

The objections raised are—

(*a*) the possibility of watering the milk from any pool infected by enteric, diarrhœa or cholera,

(*b*) the great difficulties of supervision, and

(*c*) the provision of an uncontaminated water-supply at dairies especially where butter is made.

(C) To the third plan, *i.e.*, model dairies along railway lines, the three objections above noted apply, as well as in addition—

(*d*) the difficulty of getting the milk into the market without its being subjected to high temperatures,

(*e*) the extra supervision required for the disinfection of milk cans.

(A) It might in certain instances be necessary to adopt any or all of these positions for dairies, though on the whole it would appear that the mohalla byres will give the best results in large towns. The advantages claimed and proposals for the establishment of mohalla dairies are firstly that they would be under municipal supervision, secondly, land would be acquired under the Land Acquisition Act and leased or sold either to cow-keepers at preferential rates or to philanthropic landlords such as Talukdars of Oudh, who would be asked to build model byres (which are quite remunerative investments) or as a last resource the municipality would possess one or two model dairies and would gradually erect model byres. The by-laws for the construction and sanitation of model byres are as follows:—

(1) The flooring shall consist of brick on edge pointed with cement mortar over 4 inches lime concrete. The floor shall be raised a one foot plinth approached at the door by a paved ramp of similar material to that of which the floor is composed.

(2) The standing of cows shall have a fall from the manger backwards and of 1 in 40 shall end in the manure channel or "grip" which shall be composed of the same material as the floor of 2 inches of cement covering over 4 inches lime concrete. The grip shall be 6 inches deep and 1½ to 2 feet in width to catch dung and urine which should fall into the grip. The floor of the grip will have a fall of ¾ of an inch from one side to the other and of 1 in 40 longitudinally.

(3) The length of the cow-stall from the food manger to the manure drain shall be 7 feet 9 inches to 8 feet with a breadth of 8 feet. This breadth is for two cows to a stall.

(4) The urine shall discharge into an iron bucket or pukka cess-pool with edges raised 4 inches above ground level covered by a projecting galvanised iron or stone awning to prevent the entrance of rain water.

(5) The dung shall be stored in galvanized iron or wooden tarred removable filth receptacle on a pukka floor. This receptacle shall be protected from rain and emptied daily.

(6) Every animal shall be provided with a minimum of 400 cubic feet air space.

(7) The cow-house shall be provided with permanent unclosable openings for ventilation equal in the clear to at least one square foot of inlet and one square foot of outlet per animal.

(8) Every closed cow-house shall be provided with a window one-thirtieth of floor area.

(9) The standing for animals must be kept clean and the interior of the building lime-washed every six months.

In adopting any new rules their enforcement could only be undertaken slowly as too stringent measures would be followed by a general strike of gwalas. For this reason it is suggested that one or two model municipal dairies should first be constructed as in the event of strike the total absence of milk for children would not occur (at any rate in a smaller town). The work of a model dairy and the housing of cows in a model byre would gradually be understood by the neighbouring gwalas. Model byres would then be slowly introduced in various mohallas or quarters in the towns and as erected the by-laws enforcing their occupancy by the prohibition of cow-keeping in private compounds within that area would be put into operation. At the same time the gwalas, occupying the model byres would have the right of purchase from the sullage farm, of fodder and grass at reduced rates. The amount of fodder sold, to be limited to the number of cows each man is licensed to possess in the byre. Municipal model dairies and byres would be sold when the gwalas had been sufficiently accustomed to the new methods.

(B) The introduction of milk from dairies outside the city (situated in any other position than along the railway lines) would appear to be much more difficult to deal with. Scattered in a ring round the city perhaps two or three miles from the municipal boundaries, their inspection and the provision of uncontaminated water-supplies by tube-wells or by any other method would be most difficult. The detection of adulterated or infected milk through so many avenues of ingress would be impossible unless the licensing and punishment of the milk-hawkers and middle man for milk adulteration were strictly enforced, as suggested in the concluding paragraphs of this paper.

(C) Where the railway is the method of transport more can be done to improve the milk supply. The milk for Rangoon comes in largely by the railway from a distance of ten miles. The Civil Surgeon, Hanthawaddy, was asked to report on the housing of cows and found it disgraceful,—the milch kine were stalled with dung up to their knees and in every way their surroundings were insanitary. Some animals were also found to be tuberculous. The only way to deal with this condition was by asking the Veterinary Department to inspect these byres regularly but to give the power of destruction of tuberculous cattle into the hands of subordinates was absolutely impossible.

Where, however, the milk-supply comes in by railway the following system might with advantage be adopted :—

(1) A model receiving depot must be constructed at or near the station of despatch.

(2) The stalling of the cows must be carefully inspected in the byres from which the milk is received.

(3) To provide an uncontaminated water-supply, tube-wells must be sunk near the depot or where the sub-soil level is too deep for this method the well must be covered in and padlocked.

(4) The milk depot must have a sterilizing and refrigerating plant, and

(5) the milk should be sent by rail in refrigerating cars, or

(6) as an alternative method the milk must be treated by pasteurisation.

Milk sent by train would be received in a milk depot situated near the city station, and samples would be taken occasionally for analysis. From the depot it would be despatched to the middle man. The control of the middle men will again require supervision. In Rangoon it was found that in some cases the evening milk was kept under the beds until morning and then hawked round the city. The middle men must be known as the licensed hawkers and in addition there should be a certain number of licensed milk-shops. If any of these systems are adopted the cost of milk will be increased.

The rules for licensing in United Provinces are not sufficiently stringent (*vide* copies of rules) and the final authority for enforcing the rules is the Bench of Honorary Magistrates who can never be induced to inflict a deterring fine.

In Trinidad where the milk trade is chiefly in the hands of the natives of India, the following rules for the offence of watering milk are enforced : —

(1) First offence, a heavy fine.

(2) Second offence, suspension of license for six months.

(3) Third offence, cancellation of license for three years.

(4) Every licensed milk seller must wear a numbered badge.

(5) To refuse or evade giving a sample to the inspector appointed for the purpose is an offence under the Food and Drugs Act.

(6) Appeals are carried out by bringing the cows to the Municipal laboratory and samples are taken by the analyst.

In India where poor milk can be adulterated with water and buffalo cream added to bring the specific gravity to the normal, the detection of adulteration would probably largely lie in the direction of the estimation of the solids not fat.

Rules.

Under section 128 (*h*) (*i*) *of Municipal Act.*

1. No person shall keep any cattle for dairy purposes within municipal limits, unless a license granting permission to this effect has been obtained from the municipal board.

2. The license shall be in the following form :—

(*a*) Name of person.
(*b*) Place where cattle will be kept.
(*c*) Number of cattle to be kept.
(*d*) Area of accommodation.
(*e*) Description of accommodation.

No fee shall be charged for any such license.

3. Licenses may be cancelled if any of the following conditions subject to which the license is granted are broken :—

(*a*) the premises shall be kept clean and in good order;

(*b*) the licensee shall comply with any order which the board may issue to him regarding the sanitary measures to be adopted for securing the proper cleaning of the dairy premises;

(*c*) the animals kept shall be fed on wholesome food;

(*d*) the premises shall be open to the inspection of any officer duly authorised by the board in this behalf, and orders passed by the board on the report of any such officer shall be immediately attended to.

4. The license shall be renewable from year to year.

5. Every person holding a license under rule 1 shall give immediate notice to the health officer of any outbreak of sickness among his cattle and shall immediately segregate the sick animal or animals and shall conform to such directions as the health officer may give him pending the orders of the board.

Under section 132 (1) *of Municipal Act.*

In exercise of the powers conferred by section 132 (1) of the Act, the municipal board directs that any person committing a breach of rules 1 and 5 shall be punishable on conviction with a fine which may extend to fifty rupees, or, in case of a continuing offence, with a further fine which may extend to five rupees for every day after the date of the first conviction during which the offender is proved to have persisted in the offence.

Some practical points in the Indian Milk Problem and how they may be tackled.

BY

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A study of the practical points in the milk problem demands a knowlege and consideration of some practical points in the Physiology and Bacteriology of Milk, and even at the expense of making this paper a little longer it is worthy of the subject to summarise and reflect over some of the more important of these.

PHYSIOLOGY OF MILK.—Milk contains all the essentials of a complete food, and deprivation of any of them interferes with the health of the consumer. It contains *opsonins, alexins and ferments* and a '*germicidal body*,' all of which go far to the body nourishment as well helping milk and the consumer in the fight against disease. There is no doubt whatever it contains elements, of which we know nothing, which are of special value to infants as the rearing of children either on mother's milk or pure cow's milk gives them a better constitution than those reared on artificial products. It is a liquid food peculiarly liable to take up odours, and its proximity to various odours have been known to render the milk unwholesome. Its proteid substances are of three kinds (*casein, globulin* and *albumin*) and of these casein, the most important, is present in a colloidal condition, capable of being curdled, and has special tissue forming properties of value to the sick and the infant. The fat is present as an emulsion and is the most important constituent to which the consumer looks. Its sugar (lactose) is present in a special form and is changed by lactic acid Bacteria into Lactic acid which precipitates the casein and gives ocular evidence to the consumer that the milk has turned for the bad. Milk also contains lecithin, Galactose (resembles trypsin), a diastasic enzyme, a catalase, a peroxydase and an aldehyde reductase all constituents of special value to the human economy as well as supplied by nature to effect the digestibility of milk. These practical points, of interest to the physiologist, hygienist and medical practitioner, alone demand its protection as a food stuff; but the facts that it is a food of universal use by all classes and of special value in the upbringing of the young generation and in the treatment of the sick are overwhelming reasons for the organisation of some protection against its uncleanly production and its adulteration. The consumer buys his milk for the cream which he can see, but he cannot see if the milk is *clean*.

BACTERIOLOGY.—Milk gets into it three great classes of germs, *viz.*, (1) the Lactic Acid Series, (2) the Putrefactive Series, and (3) the Pathogenic Series. For a long time it was thought that the interior of the udder was sterile, except perhaps the teats, and that failure to get sterile samples of milk was due to bacterial contamination from the teats and outside sources. Numerous experiments however are in agreement that milk is contaminated before it reaches the teats (1—16). The number of bacteria found in the udder is less than would be found elsewhere under similar conditions of food, moisture and temperature. The germicidal action of fresh milk has been cited as an explanation (7, 9). The last of the milk drawn at any one milking contains less bacteria than the first drawn but is seldom sterile. In fact strippings have been found to contain more bacteria per c c than that drawn immediately before stripping. If a cow is not stripped, *i.e.*, if a little milk is left in the udder—the next milking will shew a number of bacteria larger than usual. It is not believed that the udder is subject to indiscriminate invasion by a variety of forms, but rather that the conditions found there are such as limit the bacterial flora. The presence of bacteria in the udder is paralleled by the case of the other mucous membranes. The bacterial content of milk is not influenced by the bacteria in the feed or water drunk.

The organisms most frequently found in the udder are however *micrococci* capable of producing visible changes in milk rather tardily (5) and hence they do not interfere with its apparent keeping qualities. Conn, Esten and Stocking (17) have pointed out that one of these udder organisms (*micrococcus lactis varians*) is the most common and widely distributed organism in milk and have observed it is identical with, or closely allied to *micrococcus pyogenes aureus* (Staphylococcus pyogenes aureus). Streptococci, indistinguishable from *streptococcus pyogenes*, have been isolated from milk taken from the normal udder under aseptic precautions (10).

In America the methods of aseptic milk production have reached such a fine art that in some dairies the bacteria unavoidably introduced from the udder constitute the bulk of the bacteria present in the bottled milk. This is what can be our highest aim, *i.e.*, the production of clean milk. Cows with leaky teats show a higher bacterial count in freshly drawn milk (5). Therefore a sterile milk cannot be got under the best of conditions. The foremilk contains most bacteria (from 1,000 to 50,000 per c. c.,—the average of 70 experiments by Coun (10) gives 6,900 per c. c.). Consequently it has been suggested that a separate vessel should receive the first streams of milk from the teat so as to lower the bacterial count. But as the whole of the milk contains bacteria the contamination from the first stream has little effect upon the general average, and, since they are not harmful the suggestion seems "faddish," especially in view of the fact that it has been shown that the rejection of three streams from each teat only reduces the bacterial content of the whole milk by 4 per cent—a practically negligible amount (18).

2. THE COAT OF THE ANIMAL.—The excrement and mud adhering to the hair of the cow constitute a prolific source of contamination. The amount varies directly with the sanitary conditions of the barnyard or stall. Accumulations of manure in the yard to which cows have access necessarily aggravate the conditions. Hence the necessity for paving yards with stone, or brick set in cement, and ensuring drainage. Currying and brushing of cows is very effective and should be done at least half an hour before milking. This allows time for dust to settle. If done immediately before milking the number of bacteria will be doubled. In the best dairies in America the switch of the tail is washed before milking.

3. EXTERIOR OF THE UDDER.—Both udder and teats are exposed to contamination from the cow lying down. The movements of the udder during milking tend to throw dust and hair from both into the milk pail. Therefore the washing of the udder and teats is very necessary. These should not be allowed to drip. The effect of even damping the udder is to reduce two-thirds of the number of bacteria (19). By damping the udder and flanks the contamination can be reduced ten per cent (18). A clean bath towel can be so folded that one towel can be used on four cows, a fresh surface of it being used on each udder. A cow kneels on its forelegs before lying down, and so, to prevent the cow lying down after washing, a light clain should be passed under the throat and affixed to the stanchion.

4. THE SHAPE OF THE MILK PAIL.—The best idea is to reduce the area of the opening of the pail to the minimum size that can be used without seriously inconveniencing the milker. A covered pail with an aperture containing a cheese cloth, or wire gauze strainers, are inferior to a pail with a small area protected by a hood. The covered pail with cheese cloth strainer however is better than the common open pail, and it will exclude 29 per cent of the total bacteria and 41 per cent of the lactic acid organisms as compared with the ordinary open pail in a clean dairy, and as many as 97 per cent in a dirty dairy (20). The brass vessel of the Indian milker however has a small area.

5. THE MILKER.—The milker is *the* most important factor in the prevention of pathogenic organisms of man getting into milk, and in the production of clean milk. Success or failure depends on his training and faithfulness in carrying out details. A trained college graduate was able to get results seven times as good as two milkers (18). The practice of wetting the hands in milk which drips into the pail is common, and it is usually not the practice to wash the hands before milking. Clean overalls are not insisted on and should be a more general practice.

6. MILKING MACHINES.—It was thought this would eliminate the bacterial contamination but it has not proved an entire success. It means passing the milk through long India rubber tubes, and this, besides being objectionable, is open to the greater difficulty in cleaning, bacteriologically, rubber tubing. Further its complexity and the work involved in taking the machine apart twice a day afford an excuse for neglect. In fact Harrison (21) found hand drawn milk to be cleaner, and this was confirmed by Stocking (22). Only elaborate precautions give favourable results and those elaborate precautions at once throw it out of every day practice. Even if a disinfectant was used to clean the tubes there is always the chance that they will not be thoroughly rinsed of the disinfectant, and so as regards formalin, etc., it is safer to interdict their use. Milking machines thus increase rather than decrease the possibilities of contamination.

What is wanted is a class of trained dairymen trained in the production of *clean* milk. This would give a new employment to many in India and would strike at the root of the cause of the dirty condition of milk. These men could be trained at Sanitary Associations, Veterinary Colleges or under a Health Officer at a Model Dairy. Gowalas could be easily so trained as I have suggested. Municipalities could give such appointments to dairies carrying out first class licenses or extend this free service to all dairies outside Municipal limits from which milk is brought into their area.

7. THE STABLE OR BARN.—The Sanitary condition of these is most important. All that is required are conditions enabling easy cleaning, freedom from dust, good ventilation and good lighting. The cow is by natural habits an open air liver. Elaborate buildings are not required. In fact if she has a good clean floor and no shed over her she is likely to be a healthier animal than cooped up in a given cubic space which is ill-ventilated and badly lighted. It is when many of them are put together under a roof that the question of cubic space becomes an important matter and it is an expensive one to the owner. Local climatic conditions will help in deciding the point.

The floor, however, should be cemented as it ensures easy cleaning and cannot become saturated with filth and give rise to offensive odours as a wood floor does. By the construction of a gutter behind, the drainage can be made efficient. Shavings make good bedding with a minimum of bacterial contamination. Wooden Mangers should be avoided. In colder climates the housing question arises and the cubic space should be 1,000 cubic feet per cow. The wells should be annually whitewashed. Manure should be kept in a waggon capable of daily removal or in a pucca raised bin with cemented floor with a wire gauze door to prevent the breeding of flies. Cowdung cakes should not be permitted in a barn yard.

8. THE FEEDING OF COWS.—Is most important. The dust in the air occasioned by the feeding of grain and hay during milking, increases the bacterial contamination of the milk drawn during milking by one-third of that of the cow milked when not feeding—other conditions being alike (18). This unnecessary practice can be broken off.

Certain feeds are highly objectionable because of their effect on the cow. Brewer's grains, distiller's grain and beet sugar pulp are a cheap source of feed and cause diarrhoea and many Indian cows are fed on very inferior food mixed with dung, &c. It is not unlikely the milk of cows fed on such fermentable and inferior foods will contain products in milk not found in the milk from cows fed on wholesome food. Therefore there is a serious problem here—how best to supply cheap fodder for dairies.

Special milking rooms are unnecessary and an open shed on pasture land offers good conditions for milking as regards contamination from the air.

9. CLEANSING OF UTENSILS.—This is a very important factor in reducing contamination. It is a precaution easy to carry out but none is more often neglected or imperfectly done. Rinsing in cold or lukewarm water is first necessary to remove the milk. If hot water is used it causes some of the milk

constituents to adhere to the can and renders cleaning more difficult. After the preliminary cleaning scalding is necessary. Sterilisation is not practicable in actual practice as it would require the utensils to be subjected to steam under pressure of at least five pounds for 20 minutes. But boiling water should be insisted on. The use of wood or bamboo utensils is undesirable owing to the impossibility of their proper cleansing. Municipalities could supply utensils at a cheaper rate to milk sellers than they could purchase by buying at retail prices.

10. SEDIMENT.—The deposit in milk consists of mud, fæces, hair, grass, cloth fibres, bacteria, &c. By a centrifugal machine this dust can be removed but not the bacteria which remain in the milk and may be increased by separating the clumps (23, 24, 25). Thus a centrifugal machine is not necessary.

SIGNIFICANCE OF BACTERIAL CONTAMINATION.—No food so universally used by man is exposed during its preparation to a greater variety of contamination as milk is. No food deserves more attention. The constituents of the milk, and the form in which they exist, together with the temperature offer most favourable conditions to the growth of bacteria. Fat is the only constituent of milk which resists the action of the common bacteria of the air.

At 10° C. (50° F.) milk may be kept for 2 or 3 days.

At 20° C. (68° F.) milk sours in 50 hours.

At 37° C. (99° F.) curdling occurs in a few hours.

B. LACTIS ACIDI.—Is the typical lactic acid organism but even its own growth is limited for its multiplication is checked by its own product—lactic acid.

The lactic acid organism gets into milk chiefly from the air of the stables and the dust shaken from the cow, another important source is a dirty utensil. Another source not usually recognised is where brown hay (which is produced by lactic and butyric acid fermentation) is used in place of air dried hay, and where sour fodder is used. The lactic acid organisms thus come from *external* sources and the interior of the udder is of no importance as a source. (26).

Putrefactive Processes are more important from a hygienic point of view than the souring of milk. Decomposition changes in the nitrogenous compounds (casein and albumen) of milk is designated putrefaction, and in the process the milk assumes an alkaline reaction. Some of the products of this decomposition are toxic to man and unfortunately the changes are not noticeable (like the souring of milk) to the consumer. Fortunately however, the putrefactive organisms do not readily grow under conditions favouring souring of milk. In this sense souring of milk is a beneficent process protecting milk against a worse decomposition, and is nature's method of warning the consumer. Putrefactive organisms however are able to grow at temperatures somewhat below 20° C. more rapidly than the lactic acid organisms. Hence milk kept at low temperatures is more apt to putrify than to undergo souring. Putrefactive organisms come from the dust of the stable air, flanks of the cow, dirty utensils and the dust of dirty shops where milk is sold, besides with the use of dirty water.

"Ropy" condition of milk is caused by a special germ (*the bacillus lactis viscosus*) (27) and the condition may occur with skimmed milk but the presence of cream accentuates the viscosity. Whilst dirty water may be the source of the organisms the condition is usually the result of utensils being insufficiently scalded as thorough scalding of utensils prevents the condition.

GERMICIDAL ACTIVITY OF MILK.—When freshly drawn samples of milk are examined at different intervals for numbers of bacteria; it has been proved that there is no immediate increase in the numbers and frequently there is a decrease. Whilst the evidence in favour of the existence of a germicidal substance in milk is distinct, further experiments have shown that agglutination seems to a large part to explain the apparent decrease in numbers. But even allowing for this it is evident that raw milk does exert a restraining influence on the multiplication of bacteria as compared with heated milk. (Heat destroys the germicidal action of milk.) The evidence to date, however, does not warrant recommending any change in the general practice of rapid cooling of milk. (28).

11. EPIDEMIC DISEASES TRANSMITTED BY MILK—I do not intend to enter at any length intothis aspect of the subject as the evidences of these are numerous and the references enormous. I will simply enumerate the various diseases that can be so transmitted and give only some references to authorities in my appendix. Milk may transmit and may be contaminated by the following disease products, (1) Tuberculosis, (2) Enteric, (3) Cholera, (4) Diphtheria, (5) Epidemic diarrhœa, (6) Scarlet fever, (7) Actinomycosis, (8) Mammitis, (9) Cow pox, (10) Foot and Mouth Disease, (11) Anthrax, (12) Rabies, (13) Milk fever, (14) Red water, (15) Abortion. The first six diseases are the more common and amply warrant protective action being taken.

Tuberculosis is so serious an affection among the community that some evidence of its relation to milk seems necessary here. The evidences are numerous but the most conclusive evidence that tuberculosis is spread from cattle to man is to be found in the report of the British Royal Commission (second interim report. *Journ. comp Path. and Bact. Vol. XX 1907. P. 81*). In addition it is an important practical point here to note that the manure of cattle contaminated with tubercle bacilli is regarded as an important source of tubercle bacilli in milk (38). Reacting tuberculous dairy cows that retain the appearance of health, may actively expel tubercle bacilli in fæces (39—42). The tubercular udder, whether diseased so badly as to permit detection or so slightly as to escape detection on physical examination, gives off tubercle bacilli. Cows secreting virulent milk may be affected with tuberculosis to a degree that can only be detected by the turberculin test. The *turberculin test* is the only available means for detecting tuberculosis in cattle at every stage of the disease beyond the incubation period and by its means the diseased animal can be separated from the healthy. A tuberculous animal in a herd is an actual danger to all the others. Municipalities cannot legislate for the eradication of tuberculous cattle. They can only ensure a pure milk supply but so far as tuberculosis is concerned they could require all cows to pass the turberculin test, and this should certainly be a condition for all first class licenses. The public have an abhorence and fear of consuming tuberculous meat and so demand meat inspection, but the same undesirable qualities are possessed by the milk of tubercular cows, only worse, for it is not the practice to cook milk. Therefore although it would be years before any such adoption of the test would be general yet the present practice should be discouraged and the health of the public safeguarded by gradually insisting on the turberculin test in better class licenses. At Washington the milk from all cows that have not passed the tuberculin test is compulsorily pasteurised. Chicago has adopted the scheme of enforcing the tuberculin test with the alternative of Pasteurization. There is no doubt whatever that neither of these alternatives could be introduced into India at this embryonic stage of the problem, but what could now be done is that in conference with the gowala the test could be permitted to be done or the alternative may be voluntarily agreed to. I do not think that when we have trained dairymen, or such are supplied free by Municipalities to dairies, we will have much difficulty in applying the turberculin test. I am certainly one of those who believe in slaughtering affected animals and indemnifying the owner by the Municipality. But having enquired into the relative prevalence of tuberculosis in cattle in India it is a pleasure for me to inform you that the disease is not common. Not having found tuberculosis of cows at all common in Lahore and not having seen a single case in buffaloes, I got quite interested and wrote to the various Veterinary Colleges in India to find out their experience. The result was to support my observations. Thus the Principal, Bombay Veterinary College, wrote "Tuberculosis among cattle (cows and buffaloes) is, according to my experience, an extremely rare disease. No cases have been detected here for years and I believe I am correct in saying that no cases have been seized in the Bandra slaughter-house for many years. The disease does exist. I have come across a few cases in dairy cattle in Gujrat." The Principal, Punjab Veterinary College (now at Calcutta), writes "In my experience tuberculosis is exteremely rare in buffaloes."

The Principal, Bengal Veterinary College, wrote "Few buffaloes are admitted into the Hospital except for worms and rhinderpest, buffalo-cows are extremely rarely admitted. We have had a few cases of undoubted and fatal

tuberculosis in buffalo-bullocks but in every instance they have been the property of Municipalities and used for scavenging. The admission of Zebus under all heads being more numerous more cases of tubercle have also been diagnosed. The admission for tuberculosis in this College cannot be taken as any criterion of the amount of the disease which may or may not prevail."

The Principal, Madras Veterinary College, wrote, "not a single case of tuberculosis among buffaloes has come to my notice in this College Hospital or in the city, and provinces of Madras."

The Superintendent of the Civil Veterinary Department, Rangoon, sent me a statement showing the number of carcasses or portions of carcasses and organs of buffaloes, cattle and pigs rejected on account of tuberculosis and the number slaughtered at the Rangoon slaughter-house.

The statement shows that for the five years 1906-1911 out of 12,074 buffaloes slaughtered only 6 carcasses were rejected and only 84 lungs were rejected for tuberculosis. That in the two years 1909-1911, 676 lungs of cattle were rejected for tuberculosis." These statements are of practical value because it shows the infrequency of tuberculosis of cattle and hence the practicability from the economic point of view of giving compensation for seizure of infected animals as proved by the tuberculin test. It also shows that if measures are taken in the sanitary condition of dairies and the sanitary production of clean milk that the fear of tuberculosis by milk in India can be eliminated. Further it shows the high value to be placed on the milk of the buffalo cow, and though the percentage of cream in such milk may be too high for some adults and for children yet the percentage composition can be easily modified and a larger amount of safe butter is obtainable. Whilst these statements may be taken as true I would use caution in applying them to cows herded together in insanitary quarters inside congested areas. Thus tuberculosis in man in India would appear to be caused from 1, infection from man to man through sputa, etc , favoured by bad sanitary conditions. 2. In congested areas in the inhalation of the debris of infected cowdung cake by man. 3. In congested areas in the debris of infected cowdung and cowdung cakes entering milk 4. To a minor part generally by milk of infected cattle with possibly a greater relation to this cause in congested areas. The prevention measures are self indicated and do not require greater notice in the subject of this paper. As regards tuberculosis in cattle it is important to note that the disease among cattle is rarely inherited and that it is spread among cattle by infected cattle and by the practice of feeding calves on skim milk. In this last case the most practicable scheme to prevent tuberrculosis is by heating milk.

The pig is peculiarly susceptible to tuberculosis and in districts where pigs have been fed on skim milk and whey they have become infected. Pigs should not be kept in close contact with dairy cows. Where pigs were raised in association with beef cattle in America so as to utilise the dung of cattle for their feed the magnitude of the losses drew attention to the contamination by fæces as a source of tubercle bacilli in milk (39, 40, 41).

12. MUNICIPAL CONTROL OF MILK SUPPLY.—This is by a licensing system which states the conditions of the license and should, but usually do not, define the qualities required in the milk sold, and also should specify that certain methods shall or shall not be practised in its production. Indian licenses are usually a farce as they do not go far enough. Licenses should be granted annually with provision for a revocation of license and by exaction of penalties through the courts. A licensing system which does not touch the conditions of milk production will not ensure a clean milk supply. A licensing system without a laboratory also will not ensure it.

INSPECTION.—The inspection of equipment of dairies and milk shops, methods of handling, sanitary conditions, etc., should form an essential part of Municipal control. In actual practice the inspector will fall far short of accomplishing the best results unless he himself is an instructor in dairy practice—*because the people must be taught* and he should not be only an agent to detect violations of the license. He must point out the defects *on the spot* and teach the way of improvement (giving reasonable time for improvement, which if not

carried out would be carried to prosecution. Sanitary inspections of dairies might be recorded by score sheets as in America.

NUMERICAL DETERMINATIONS OF BACTERIA IN MILK.—Numerical determinations of bacteria in milk are an index of the care exercised in handling of milk. But unless such counts can be made by competent persons from samples properly collected and cared for they had best not be made at all. The average bacterial count of milk of Rochester declined in three years to one-fourth of the numbers prevailing before such work was undertaken, whilst Boston shows a very high percentage of reduction. Boston set a limit of 500,000 per c. c. and this has been generally followed for city milk. Finer grades of milk have higher standards, thus, 'inspected milk' 100,000 per c. c. and 'certified milk' has a standard of 10,000 per c. c. A bacterial standard need not be the subject of legislation but the work carried out merely as a guide to inspection work, at a municipal laboratory.

EDUCATION OF PUBLIC.—The market for cheap and dirty milk can only be destroyed by educating the public. Clean milk costs a little more but people will not pay the increased price till they can see the advantage. Dairies and milk shops carrying out first class licences should be advertised free. Public education includes :—(1) The care of milk at home, (2) cleanliness of utensils, (3) home pasteurisation and the keeping qualities of pasteurised milk, (4) the need for clean milk and the dangers of dirty milk. The education can be accomplished by advertisements in the papers, hand bills, lectures at women's clubs, at schools, at a model dairy, etc.

PASTEURISATION.—Is a generic term including many processes of heating milk followed by cooling. The temperature varies from 140° F. (60° C.) to 185° F. (85° C.). The temperature at which it is cooled is an important factor in the process.

The chief incentive to pasteurisation is the killing of Pathogenic germs and the keeping qualities of milk. Tubercle bacilli is the chief organism and 140° F. (60° C.) for 20 minutes is fatal to it (47, 48, 49). Both B Diptheri and B. Typhosus are also killed at this temperature and B. cholera. If you want to kill the B. tubercle in one minute a temperature of 160° F. (71° C.) is necessary. Pasteurisation is not to be recommended as a general measure in my opinion as it removes the incentive to produce clean milk, but it is useful for home practice and in the case of sudden outbreaks traceable to milk.

A TEMPERATURE OF 140° F. IS THE MOST SUITABLE because :—

(1) A cooked taste is not left in the milk. This is left permanently in milk by exposure to 158° F. (70° C.) for 15 minutes. (Ten minutes at 160° F. (71°C) is safe.

(2) The Chemical constituents of milk are not altered by it. Higher temperatures especially near the boiling point bring about profound changes.

(3) The creaming quality is not affected at this temperature.

(4) The vital qualities of milk (the protealytic, oxidising, and fat splitting ferments, the alexins and the germicidal phenomenon) are not affected by it. An exposure of not more than 140° F. for 40 minutes avoids impairment of all these qualities. Russel has shown that an exposure to 140° F. (60°C.) for 20 minutes results in the destruction of as great a number of bacteria as by exposure to higher temperatures for the same time (50). The bacteria remaining after exposures to 160° F. were in the spore form and were uninjured even by much higher temperatures (Bacterial spores constitute less than 1 per cent of bacteria present). Milk which would ordinarily sour in two days could keep fresh for six days when pasteurised at 140° F. for 15-30 minutes (51). Over 99 per cent of the bacteria were killed.

Pasteurisation is thus the most useful method of attacking milk in times of milk borne epidemics. The process of Pasteurisation should include cooling to at least 50° F. Unless cooled the few bacteria that have survived the heating multiply enormously. Bacteria cannot stand sudden shocks in temperatures.

Pasteurisation is the only effective measure that can be put into force *immediately* against any danger from tuberculosis, enteric, diphtheria, cholera, etc., from milk.

In a recent cholera outbreak in Lahore, pending the finding of the cause, I tried the practicability of seizing milk coming into Lahore at certain octroi posts. I had cheap *chulas* made of brick and mud and the milk in the brass vessels conveying it was heated to 140° F. The cooling was capable of being effected in the cement sump around a water standpost. It was important to employ Hindus to both carry the brass vessels to the *chulas* and to put the thermometers in the milk or otherwise Hindus would not touch the milk touched by Muhammadans. The cooling was not desired by the sellers of the milk. Certain Hindu shop-keepers, however, who did not know what was done by the sellers in heating the milk refused to buy the milk which Muhammadan shop-keepers brought. A photograph shows the temporary cheap arrangements made to carry out the Pasteurisation at one of the places. The epidemic, however, was probably due to another cause, and the pasteurisation was soon given up.

For the production of clean milk the place for action of primary importance is at the farm or place of production. Here we must get. It is no use trying to have Municipal licenses with sanitary ideals if nothing is done to ensure sanitary conditions at the spot outside Municipal areas. To get a clean and pure milk supply you must come off your perch of high ideals and meet the *gowala* in conference. He has to be taught the *raison d'etre* of our action and that only simple unobjectionable sanitary precautions are necessary. Health Officers cannot possibly have the time to do this and neither can Health Officers alone bring about a clean and pure milk supply. The education of the gowala or milkers should be after the manner I have indicated, and to help these men in sanitary improvements, for which expense is necessary, certain octroi charges could be lessened; and to perpetuate the sanitary conditions prizes should be offered. It is a mistake to think the *gowala* will not learn the simple sanitary precautions necessary to produce clean milk as I have found that they can be taught and show you some photos in proof of this.

Indian milk shops.—With reference to the milk sold in the open shops in the Indian bazaars it is of importance to remember that in most cases the method of milk production is the main factor in producing harm. When the milk comes to the shop it is generally heated or boiled sufficiently to kill the lactic acid organisms. Therefore the milk is open to two sources of danger, *viz.*, putrefaction and pathogenic organisms mainly from the air and by flies respectively. The chances are in favour of putrefaction if the milk is not sold quickly. The chances of pathogenic infection are probably much reduced either by the upper hand gained by the putrefactive organisms or by the quick growth of other lactic acid organisms which have gained admission. The danger of epidemic disease is much lessened by the established practice of heating or boiling and were this not so we should have much more disease than we have. Again the custom prevails of curdling milk which also counteracts against both pathogenic and putrefactive dangers. The recommendation to use muslin to vessels containing milk in such shops has little to recommend it because such muslin will not be kept cleaned and by constant handling gives an added danger. The only recommendation to keep out flies is to have wire gauze covers and this I insist on although it is not a condition of our licenses but I have not had the slightest difficulty in getting milk sellers to provide them before getting a license. There is another suggestion in this line which I intend to try with milk sellers and that is the provision of a small wooden box lined with pieces of tin and made water tight so as to hold water. Into these the brass milk vessels can be kept in water to which ice could be added. The cover of the box is removable with apertures over the mouths of the vessels and over each of these a wire gauze cover is held in position by a hinge. A model of this is shown. No provision however in dealing with these milk shops must interfere with the necessary attack against insanitary conditions of production at the seat of source.

Thus gentlemen you see the milk problem involves the consideration of many points and many of these points require definite agreement for some uniform line of action.

My recommendations are these :—

1. That Local Governments should train *gowalas* or men for dairy work. This could be done either at a Veterinary College or at a model dairy, and these men should get certificates. Municipalities if they choose may also do so.

2. That Veterinary students should be trained in the sanitary conditions necessary for the production of a clean milk supply.

3. That Municipalities engage and give free to all dairies certificated dairy men. A Veterinary Surgeon trained in clean milk production should be engaged to make inspections.

4. That Municipalities should encourage better sanitary conditions of dairies outside these areas by reducing octroi charges and by offering prizes for the carrying out of the necessary requirements to ensure the production of clean milk.

5. That Municipalities should encourage better sanitary conditions of dairies inside Municipal area by having first class licenses with prizes.

6. That all first class Municipalities should provide a laboratory for milk analysis.

7. That for all other Municipalities local Governments should have a provincial laboratory where samples could be sent for tests.

8. That a Milk Commission is required consisting of a Sanitary Commissioner, three Health Officers, two Veterinary Officers, two Muhammadan gentlemen and two Hindu gentlemen and a Director of Agriculture to decide on—

   (*a*) the minimum sanitary requirements for milk shops and dairies in and outside municipal areas in each Province ;

   (*b*) a uniform standard as to the permissible amount of the various constituents of milk ;

   (*c*) a uniform standard of tests ;

   (*d*) to consider the question of grazing and fodder for cattle and the best means to encourage better feeding of animals ;

   (*e*) the best means to improve the stock and to prevent illicit slaughtering of young cows ;

   (*f*) to draft definitions of what constitutes 'adulteration' under the various terms employed in milk business and in artificial products of milk imported into the country ;

   (*g*) how best to get cheap milk to the poor ;

   (*h*) to fix the Chemical and Bacteriological standard required for milk in various provinces ;

   (*i*) to fix a uniform relation between the percentage of fats, carbohydrates and proteids of the milk of Indian cows and buffalo-cows ;

   (*j*) to find out how far cows are tuberculous ;

   (*k*) to determine the best method of gaining the co-operation of the gowalas and dairies outside Municipal limits.

9 When the local Governments and the Municipalities have carried out the recommendations which concern them then the Government of India might appoint a Milk Commissioner who will study and enquire into the methods in vogue and will annually make a report. He should have a D. P. H. diploma.

APPENDIX.

Precautions in taking samples :—

1. Thorough stirring of the milk before taking the sample.

2. I fthe sample is left long standing so that a thick layer of cream is formed, this will not readily mix with the rest of the cream. It will then be necessary to heat the milk to 40° C. by placing the vessel in hot water, after which a thorough mixing is easy to effect.

3. To send samples to a laboratory, clean, well dried, corked bottles are necessary. If only the percentage of fat is to be determined then 100 cc. will suffice. If a fuller investigation is desired then 500 cc. should be taken. In *no* case should the sample bottles be quite full or it will not be possible to get the cream, which has separated out, back into its normal state in the milk. The bottles should only be three-quarters full.

4. In taking samples for legal purposes it may be necessary to take it in the presence of witnesses, sealed up, and a written statement made *on the spot* or as to the owner of the milk, time, place, and method of sampling (recording also any marks made on the sample bottle or its label).

5. In sending samples to a laboratory it is necessary to add some preservative as samples may not be able to be analysed immediately on arrival and the time occupied in the journey may be prejudicial to testing. The following preservatives may be used :

A. Potassium Bichromate: As much of it as will lie on the point of a knife (0·5 gm. to 1 litre of milk) is sufficient to preserve it for several weeks provided the temperature does not rise very high. Bichromate does not alter the chemical composition of the milk, and though it is poisonous yet the yellow colour it gives to milk will prevent it being drunk as milk. One drawback to its use is that it causes the cream to rise more quickly than it could normally. This is due to the fact that the dissolved salt raises the S. G. of the milk. But if the milk is heated to 40° C. it is not difficult to mix the cream with this milk again. For the preservat ion of small samples of milk a concentrated solution of Bichromate may be used and one drop measured from a dropping bottle may be put into each 10 cc. of milk. With this preservative the S. G., dry matter, and ash cannot be estimated—except in case of the dry matter where the chromate added can be separately estimated by a special method. For these estimations however it is preferable to use Formaldehyde.

B. Formaldehyde. Generally a 40% solution is used known as "Formalin." 1 cc. of this will preserve a litre of milk for a long time. For smaller quantities of milk one drop formalin is sufficient for 50 cc. Formalin renders the protein substances very difficultly soluble and this renders a difficult reading in testing for fat by the Gerber's method. This however only occurs when large quantities of formalin are used (5 per 1000 or more).

6. If no preservative is added the milk may arrive in a sour and coagulated condition. In such conditions (and it serves also for sour butter milk) use the method of Weibull as follows :

The soured milk is not poured from the bottle but a rough estimate is made of the quantity in it. Say there is 200 cc. To this 20 cc. of ammonia (*i.e.*, 10% of the sour milk) is added from a burette, the cork replaced and the bottle well shaken so that the coagulated material dissolves. The contents are then emptied into a measuring beaker and measured. Suppose there is 205 cc. then the 20 cc. ammonia is deducted, leaving 185 cc. as the amount of the original milk. The S. G. fat, etc., are then determined in the usual way and the results

calculated to the original volume of milk. The method is unreliable for *very old* coagulated milk.

1. Physical Examination :

a. Flocculent matter in milk may indicate some disease of the cow or changes by Bacteria.

b. Reddish tinge may result from blood, certain foods (mangels, beet, carrots) or from colostrum milk.

c. Bitter salty flavour from disease of the udder or from practically dried cows. Also from the action of peptonising bacteria whereby peptone with poisoning properties are formed. Certain foods (mangels, turnips) give a strong flavour. Rusty and untinned vessels give objectionable metallic taste. Uncleaned wooden vessels may impart a taste.

d. Smell. A faint animal smell is usual but smell of dung is not uncommon from ill-ventilated stalls. The use of carbolic, Lysol, etc., as a disinfectant to cowsheds may impart their odour to the milk. A sour smell indicates the change of milk sugar into lactic acid.

2. SPECIFIC GRAVITY. This should not be made directly the milk is drawn as the S. G. of freshly drawn milk increases for the five hours following milking. The difference may be allowed for knowing that the difference between the S. G. of freshly drawn milk and that of the same five hours later is 0·001. (This is probably due to change in the colloidal casein.) S. G. is determined by the lactometer (that of Soxhlet is the best). This lactometer (also called a milk araometer or milk hydrometer) has a divided scale reading from 1·024 to 1·038, the distance between each division being 7·5 mm. Between the main divisions are shorter ones corresponding to 10th of a degree, so that it is not difficult with the eye to read to a tenth of a degree. The scale is graduated for a temperature of 15°C. so that at that temperature the S. G. of milk compared with that of water at 15°C. is obtained. This lactometer can be had with a thermometer in the lower part of the stem. The ordinary lactometers are unreliable. (It is not necessary to have the temperature exactly at 15°·C.—it suffices if it is between 10°—20°C. as by a table the S. G. at these temperatures can be calculated to 15°C.)

As the milk rises by capillary attraction and adhesion to the stem of the lactometer $\frac{1}{10}$ degree must be added to the reading. Thus if 30·2 is read then ·1 is added, making S. G.=30·3 (1·0303).

The S. G. of sour or coagulated milk can be done by Weibull's formula which is :

$$S=\frac{(M+A)\,S'-A.S''}{M}$$

Where S = S. G. of the milk.

S′ = „ „ milk ammonia liquid.

S″= „ „ ammonia.

M= the volume of milk in cc.

A= „ „ ammonia in cc.

The use of S. G. test is for the detection of water and removal of cream (see later on).

3. *Estimation of Dirt.* This may be done by Stutzer's apparatus, Gerber's modification of this, the Bernstein's dirt test, but the simplest is Späth's Sedimentation Glass. In this the sedimentation takes place in a conical vessel

which holds a litre of milk. The dirt collects in a glass tap at the bottom of the vessel. When it has settled all that is necessary is to turn the tap and pour out the milk. Distilled water is poured in the tap, returned to its original position, the dirt washed, and allowed to settle. This can then be weighed after washing with alcohol, ether, etc. A litre of good sour milk after standing thus should show no sediment. Quantitatively a milk carefully and clearly obtained may contain 3—10 mg. dirt per litre.

4. DETERMINATION OF ACIDITY OF MILK.

(*a*) *By Litmus paper*. Normal fresh milk has an amphoteric reaction, *i.e.*, it turns blue litmus paper feebly red, and red litmus paper blue. A distinctly acid reaction indicates souring and a predominating alkaline reaction means decomposition or milk from a diseased animal or from added water.

(*b*) *Boiling Test*. If milk coagulates on heating in a test tube it indicates it is already strongly acid. Normal milk coagulates when it contains 0·26 per cent. lactic acid. (This equals 12 cc. N/4 Na OH per 100 cc. milk.)

(*c*) *Alcohol Test*. Equal quantities of milk and alcohol (60% by weight or 68% by volume) are mixed in a test tube. The test tube is inclined so that the mixed liquid covers a portion of the side. On slowly raising the test tube to the vertical note whether any flakes adhere to the sides, for if so then the milk is strongly acid. A slight film indicates a slight degree of acidity but with fresh milk the sides are clear.

The above three methods give a rough and ready estimate as to degree of acidity but if an accurate determination is required titration with an alkali (as by the Soxhlet-Henkel method) is necessary.

5. *Determination of Total Solids*. A weighed quantity is dried at 100°C. until the weight is constant. This can be done by the Soxhlet's Glycerine drying oven.

Fleischmann's formula gives an easy method of calculation; if the S. G. and fat contents are known the total solids can be then calculated by the formula. This is:

$$t = 1{\cdot}2\, f + 2{\cdot}665 \left(\frac{100\, S - 100}{S}\right)$$

Where t = total solids expressed in percentages.

f = percentage of fat in milk.

S = S. G. of milk at 15°C.

[In this formula the S. G. of the dry matter free from fat (solids non fat) is taken to be 1·6007.]

If t and S are known f can be calculated thus:

$$f = 0{\cdot}883.\, t - 222 \left(\frac{100\, S - 100}{S}\right)$$

A simplified formula is :—

$$t = \frac{f + S/5}{\cdot 8}$$

Where S denotes lactometer degrees, not the S. G., Ackermann's apparatus may be used to calculate the total solids.

In general the total solids vary from 11–14 per cent., the average being 12·25 per cent.

6. *Determination of Fat.* This is necessary because—

(1) the customer buys his milk for the amount of cream.

(2) large dairies butter factories buy milk on percentages of cream.

(3) to determine if the milk contains the legal minimum standard.

It may be done by

(1) Soxhlet's araometer method.

(2) Wollny's Refractometer method.

(3) Extraction methods:

(*a*). Adam's paper coil method.

(*b*). Nilson's Kaolin method.

(*c*). Röse Gottliech's method.

(*d*). Lubermann-Székely's method.

(*e*). Weibull's dessication method.

(4) Practical methods:

(*a*). Lactocrite method.

(*b*). Balcock's method. (This is recommended.)

(*c*). Butyrometer method.

(*d*). Gerber's method.

7. *To distinguish Raw and Heated milk.*—It becomes necessary to find out if milk had been heated when pasteurisation was necessary in the case of milk coming from herds suffering from foot and mouth disease, anthrax, etc. Storch's test satisfies all demands. The tests used are:

A. Arnold's Guaicum test.—A small quantity of milk is put into a test tube and about 10 drops of a 5—10% tincture of Guaicum is added. A blue ring is formed in a few minutes at the juncture of the fluids but if the milk has been heated to 80°C. there is no reaction. (Before making the test the Guaicum should always be tested to see if it reacts to unheated milk as ordinary purchased tincture behaves irregularly. Arnold says that the tincture is best prepared by dissolving the resin in Acetone.)

B. Dupoy's test. He uses aqueous solution of guaicol instead of Tr. Guaici. To 1cc milk add 1cc aq. solution (1%) of guaiacol and one drop of Hydrogen Peroxide (3%) when an orange colour is got; if the milk has been heated to 10°C. there is no change in colour.

C. Storch's Paraphenylene Diamine test. 5cc of milk are put in a test tube, and one drop of a 2% soln. of Hydrogen peroxide is added from a dropping bottle, and also two drops of a 2% Paraphenyline diamine (also from a dropping bottle). The test tube is well shaken and if the milk has not been heated at all and is not above 78°C. there is produced an intense blue colouration. If at once or after half a minute the milk becomes bluish grey it shows it has been heated from 78°—80°C. If there is no colour it indicates heating above 80°C. This sensibility of the test is so great that an admixture of 10 per cent of milk which has been heated to only 78°C. suffices to make the whole volume of the milk to react to the test.

8. TO DETECT ADDITION OF WATER.

(1). *The nitrate test.*—Pure milk does not contain Nitric-acid or nitrates.

(*a*). *Soxhlet's nitrate test.* (Too complicated for general use.)

(*b*). ***Fritzmann's nitrate test.***—To 10cc milk add one drop of 10% sol. formaldehyde and 10cc commercially pure sulphuric acid (S. G. 1·815) ; if nitrate present it is indicated by a bluish violet colour (only shown in the presence of protien).

It must be remembered many waters contain no nitrates, so that definite conclusions cannot be drawn from a negative result. Even a positive result can only throw ***suspicion*** on the water and not give a ***certain*** proof of added water.

2. By the determination of the S. G., the fat, and the total solids (or by Fleischmann's formula).

Ordinary normal milk has only very exceptionally a S. G. below 1·029 (=29 degrees of the lactometer). If water is added the S. G. sinks as much as three lactometer degrees for each 10 per cent water added. If normal milk has 30·6 lactometer degrees it would only have 27 degrees after 10 per cent addition of water and 24·5 degrees if 20 per cent water. Hence 28 degrees would throw suspicion and less than that would certainly indicate water added.

If S. G., fat contents, total solids, and solids non-fat are abnormally low then the milk has been adulterated with water. (The percentage of fats in the total soldis undergoes no change with water added.)

(3). ***Bialon's number from a formula :***

$$\sigma = \frac{100\ s-f}{00-f/0\ 933.}$$

If the number σ sinks below 1·0323 the milk is to be suspected because this number is the lowest obtained from a long series of estimations of the S. G. of ***fat-free*** milk.

Determination of the freezing point of milk.—J. Winter showed that the freezing point of milk was constant at ·555°C. and he and others have shown that pure unadulterated milk never has a higher freezing point than—0·54°C., but a small addition of water at once raises the freezing point. [From a table the percentage degree of added water can be obtained for every degree of rise in temperature.]

(5). ***Determination of the Refractive Index of milk serum.***—[The Zeiss-Wollny milk refractometer can be used for this.]

9. ***The Removal of cream.***—Fleischmann's formula can be used.

For rough methods the creamometer may be used. If S. G. is normal and amount of fat is low suspicion is aroused, for a low S. G. normally will indicate low amount of fat.

When part of the cream is used or the milk diluted with separated milk there is in each case a change in the percentage amount of fat in the total solids. After the amount of total solids have been calculated by Fleischmann's formula then the percentage of fat in the total solids is calculated from formula p=1000 feet. If the percentage of fat in the total solids is less than 19·9 then the milk has either had cream removed or separated milk added.

10. CALCULATION OF ADDED WATER.

(*a*) ***Herz's formula :***—

$$X = \frac{100}{r}\left(r - r'\right)$$

X = water added to 100 parts of milk.

r = percentage of solids non-fat in stall sample.

r′ = ,, ,, ,, suspected.

(*b*) ***Ambühl's formula.***

$$X = \frac{S - S'}{S}\ 10$$

S = S. G. of stall sample.

S′ = S. G. of suspected sample.

Less than 1 per cent. water is difficult to prove but when more than 10 per cent. has been added there is no difficulty in getting absolute certainty with the above formulae.

[The stall sample should be taken at the same time (24 or 48 hours later) as the suspected sample is said to have been obtained.]

11. *Calculation of amount of cream abstracted.* Herz's formula :—

$$Y = f - f' + \frac{f(-f')}{100}$$

Y = Fat removed as cream from 100 pts. milk.

f = amount of fat in the suspected samples.

f' = „ „ stall „

12. *Admixture with Goat's milk.*—If 25 per cent. ammonia is added to goat's milk there is a precipitation of proteins which does not occur with cow's milk because the casein of cow's milk goes into solution. 20cc milk are heated to 50°C. allowed to stand at this temperarture. Then 2cc of 25 per cent. ammonia are added, and the whole well shaken, the shaking to be repeated each half hour for 2 or 3 hours. At end of this time a layer of protein has formed under the cream. If such occurs it is evidence that Goat's milk has been added. When milk contains 20 per cent Goat's milk the precipitate is 2 per cent ; where 50 per cent is present the test tube is almost completely filled by precipitates. An addition of less than 20 per cent Goat's milk cannot be proved by the test.

13. *Fermentation test.*—A simple test to prove if milk is normal or faulty in a bacterial sense is the change it undergoes when kept at a temperature of 38°—40°C. The test only requires a simple apparatus. A number of test tubes either small (holding 40—50cc) or larger ones (holding 120—140cc) are fitted into a metal stand. (The larger ones are preferable as in them the test is more reliable and easier to judge. The smaller ones have the advantage that they take up less room and so a larger number of tests can be made at the same time.) The test tubes are furnished with caps of metal or rubber. The test tubes are placed in a square vessel made of tin plate which holds water and which can be heated by an ordinary spirit lamp. In the lid of this water bath is placed a thermometer, the bulb of which dips into the water.

The most important point to note is that the test tubes must be sterile as of course unless they are the changes which occur in the test could be due to the test tubes containing Bacteria. If a steam steriliser is not at hand the test tubes must be washed with hot solution of Soda, then washed in hot water, then rinsed in cold water previously sterilised. The test tubes are numbered and after the milk has been put into them to 1 cm. from the top, are placed in the bath the water of which is at a temperature of 40°C. and left there for 12 hours. During this time the temperature of the water is constant between 38°—40°C. At the end of the 12 hours the samples are taken out and the appearance, smell, etc., serve as an indication of its bacterial content. If the milk was quite fresh there should be no change beyond acquiring pure sour smell. Should it be completely and homogeneously coagulated it is not an indication that the milk is not so good for the lactic acid bacteria have still the upper hand, but the condition points to a considerable time having elapsed since the milk was drawn. If however the coagulation is irregularly flocculent and there are large quantities of whey then there has not been a due regard to cleanliness. If the smell is unpleasant and there are gas bubbles then the milk is absolutely unfit for human consumption. Sometimes a clear layer is seen below the cream while the rest of the milk is evenly coagulated. This is caused by the so-called peptonising bacteria (principally hay bacteria) and is an indication that these unwelcome guests are present in large numbers in the milk. This fermentation test is used in various countries, particularly in Switzerlan, for testing milk delivered to cheese factories to ascertain its suitability for making into cheese. It is a simple test and could be well with much advantage be extended to any laboratory, for from this test a good notion is obtained of the bacterial condition of the milk. But

the worthiness of the test depends in the tubes being *sterile :* otherwise the results are worthless.

14. *The Reductase test.*—Many have shown that there is a distinct parallel between the number of organismsmilk and the time required, under certain conditions, for a solution of methylene blue to be decolourised. The test is very easy to carry out. A few grams of methylene blue in powder (the Zinc chloride double salt should be used) are digested with about 20cc. of alcohol for half an hour at ordinary temperature, and then 5cc. of this saturated solution is diluted with 195cc of distilled water. One cc. of this solution is then mixed with 10cc. of the milk, and a couple of cc. of paraffin oil floated over it to keep out the air; the whole is then warmed at 45°--50°C. in water bath.

If the milk becomes colourless within half an hour it must be regarded as very bad and is absolutely unsafe for feeding any children. When the decolorisation takes place within three hours, the milk may be looked upon as of second quality, whereas if the colour persists more than three hours the milk is good.

The reductase test gives approximately the relative number of bacteria in milk, whilst the fermentation test shows to what group they belong (useful or injurious). The reductase test can be recommended as a quick test to show whether a milk is fresh and has been withdrawn with due regard to cleanliness, or whether it is old and dirty.

Notes. For fat.—The Babcock test and the Ether extraction is recommended. (In the Babcock test the addition of 2cc. of an 80% solution of glycerine to the milk in the test bottle just previous to addition of acid will insure a clearer line of demarcation than is ordinarily obtained between the fat and the water in the graduated milk of the bottle.

PROTEIN estimation not necessary as a routine.

ACIDITY tests of little importance.

S. G. TESTS useful to check gross adulterations.

SOLIDS NON FAT.—From Babcock's formula a table has been made giving the percentage of fat according to the S. G. Then by adding the fat and solids non fat the total solids are got.

PRESERVATIVES.—Borax, Salicylic acid, sulphites and Benzoic acid, and formaldehyde are regarded as deleterious substances and can produce digestive troubles.

Test for Borax.—Immerse a slip of turmeric paper in about 100cc. milk to which has been added 7cc. of concentrated Hydrochloric acid. If Borax or Boracic acid is present, on drying, the paper acquires a peculiar *red* colour which is changed by ammonium hydrate to a dark blue-green but is restored by acid. A negative result is not conclusive and would require further tests.

Test for formaldehyde.—To 10cc. milk in a test tube add half the volume of concentrated commercial sulphuric acid, pouring it carefully down the sides of the tube to form a layer at the bottom. A violet zone at the junction of the two liquids indicates formaldehyde. This test will not indicate an *excess* of formaldehyde. Then use *Leach's test*, which is :—

Commercial Hydrochloric acid (S. G. 1·2) containing 2cc. of 10% ferric chloride per litre is used as the reagent. Add 10cc. of this to an equal volume of milk in a porcelain casserole, and heat slowly over the free flame near to boiling, holding the casserole by the handle and giving it a rotatory motion during heating to break up the curd. The presence of formaldehyde is indicated by a violet coloration varying in depth according to the amount present. In the absence of formaldehyde the solution turns brown. By this test one part of formaldehyde in 250·000 parts of milk is readily detected before the milk sours. After souring the limit of delicacy of the test has been shown to be only 1 part in 50,000.

[It should be noted that if cotton is used as a strainer to the milk the absence of formaldehyde in the cotton must be proved.]

Watering of milk.—The effect of water is to lower the S. G. and the percentage of the ingredients. The determination of fat alone is not sufficient to indicate added water. If added water is the only sophistication then the S. G. test is of great value. A low S. G. with a low fat content is a sure indication of added water. This can be further confirmed by the immersion refractometer by which a reading below 39 indicates water and one between 39 and 40 is suspicious of such. A low sugar content (below 4%) with a low S. G. and fat indicates added water. Adulterated milk, so far as water is concerned, is milk containing more than 88 per cent of water.

The Bacterial Count is undoubtedly the instrument by which the effectiveness of good dairy methods is measured and it is a prominent factor in the development of these methods. Slack from a long series of investigations found it possible to tell from the number of Bacteria in the smear of milk whether or not plate cultures would show above or below 500,000 colonies per cc.; an error of less than 1% was made in this method.

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PART VIII.

VITAL STATISTICS.

MORTALITY IN COSSIPORE-CHITPORE, AND ITS CAUSES.

BY

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If I venture to lay before you " Mortality in Cossipore-Chitpore and its causes," it is not because the town is an important one, but because it gives us an opportunity to see how an inaccurate register of vital events would keep us in the dark as to the influence of defective sanitation on the health of the public, how it would throw little light on the actual evils that are at work and would even divert our attention into wrong channel and how it has been brought to a fair state of accuracy here and, for the matter of that, may be brought to the same state in other towns.

Conditions of the town.

The town is a suburb of Calcutta just to the north of it, being separated by a canal crossed by three bridges. It is small, it covers only 3·43 square miles. It has a thriving jute business, besides other factories and industries. The population was 48,352 by the census of the last year ; it is greatly augmented during the jute season and contains a preponderatingly large proportion of healthy adult males, low caste Hindus and Muhammadans, from various parts of the country, specially from Bihar and the United Provinces of Agra and Oudh gathering here to earn wages as labourers, carters, etc., and residing temporarily in the basti huts which number 4,427 out of 5,453, *i.e.*, 81·2 per cent. of the total number of houses. The immigration which goes on throughout the year from such an extensive area necessarily entails importation of Malaria and other infectious diseases into its different localities.

The town is low. It is almost flat, sloping very gently from the river Hughli on the west and discharging the drainage through systems of open drains, mostly kucha, into the cuttings along the Eastern Bengal State Railway which bounds it on the east and thence through the culverts on to the paddy fields and swamps beyond the line excepting that of a small portion which runs into the river. As the paddy fields and swamps are silted up and most of the culverts narrow, the storm water is headed up in the drains and inundates the low lying areas near the railway during and for some time after rains. It collects also in the paddy fields in the rural areas, in the swamps and in the tanks and pools of which there are as many as 984 and most of which up to within a few years were grown over with weeds and vegetations. As might be expected, the Anophelines are fairly abundant, we having here four species of it, *viz.*, A. Rossi, A. Fuliginosi, A. Nigerrimi and A. Barbirostris.

The rooms of the huts in which the people huddle together at night are, in many cases, dark and ill ventilated and offensive, well calculated to be the homes of the Pulmonary diseases, especially of Phthisis. Their damp kucha floors are literally riddled with the burrows of rats of which there are here, as in Calcutta, four species, Mus Rattus, Nesokia Bengalensis, Mus Decumanus and very rarely Nesokia Bandicota ; while in their dark impregnable strongholds under the low Manchas or bamboowork platforms of the shops of the grocers and grain-dealers as well as of the sweetmeat shops, these vermin thrive unmolested being kept down by the epizo-otic itself.

As in all other towns with service-privies, the earthenware receptacles, which once under the squatting platform are never removed and washed, but simply scooped out every morning with another piece of earthenware, the ' sara, ' offer, in their perennial coating of filth, excellent nurseries to the flies.

The numerous tanks and pools, besides contributing there quota of mosquitoes to Malaria and Filariasis serve as reservoirs for stocking and spreading the filth diseases, Typhoid fever, Cholera, Dysentery and Diarrahœas which are endemic among the huts on their borders the people bathing and washing their dirty clothes in them and, at the same time, using their water for all sorts of domestic purposes including washing of plates, cups and tumblers in which, while yet wet, they keep their drinking water, milk and other articles of food. On an

out-break of Cholera, it becomes an extremely arduous task to check its dissemination, as the people, ignorant and reckless as they are, would, but for our guards, continue in this filthy habit in spite of our warnings and instructions making no exception to the linen soiled with the dejecta of the Cholera patients.

MORTALITY.

Eminently favourable as the above conditions are to all the infectious diseases that prevail in Bengal if we turn to the Register of births and deaths of the decennium ending in 1910, we find the mortality in Cossipore-Chitpore to be very low down to the year 1908, much too low in comparison with those of Calcutta and the district and yet rising suddenly in 1909 and exceeding them next year.

Table showing mortality registered in Cossipore-Chitpore during the decennium 1901 to 1910 and comparing it with those of Calcutta and the District.

Year.	Mortality in Cossipore Chitpore according to register.		Mortality per mille per annum.	
	Actual number registered.	Ratio per mille per annum.	In Calcutta.	In 24-Parganas.
1901	590	14·47	38·28	22·94
1902	520	12·76	37·04	30·80
1903	502	12·31	35·10	32·56
1904	370	9·07	32·72	29·60
1905	439	10·77	37·95	30·32
1906	422	10·35	35·73	29·84
1907	514	12·61	37·63	34·02
1908	310	7·60	32·65	28·06
1909	1020	25·03	34·14	20·76
1910	1182	29·00	27·98	21·76
Average of the 1st 8 years.	458	11·24	35·83	29·77

Flattering as these returns were, the Commissioners of the Municipality were not convinced and far from being lulled into a sense of security began since the year 1900 to keep a record of their own by collecting at the end of every month, reports from

1. Cossipore Burning Ghat,
2. Saharbangla Mohummadan burial ground, } within the town and
3. Kasi Mitra's Burning Ghat in Calcutta, largely resorted to by the people of the southern portion.

Registers are kept at the places of disposal in Calcutta; and the Commissioners appointed two clerks for the two places within their jurisdiction to keep records in the form of the register of all deaths disposed of in them: and the monthly reports were called from these books.

The other places of disposal in Calcutta were left out of account; it was thought that the number of bodies taken to them must be too few to vitiate the vital statistics appreciably.

As these books at the burning ghats and the burial grounds were often the only sources of information of occurrence of an infectious disease in any part of the town, I made arrangement soon after my appointment in June, 1905 for getting reports from them daily. As cases of infectious deaths were found missing from time to time and as mortality in some of the most insanitary localities which one would expect to be the scene of deaths was found to be very low, the registers kept at these out of the way places in Calcutta for the quinquennium 1903—1907 were examined and found to account for over 20 per cent of the corpses of our town.

Table showing actual mortality in Cossipore-Chitpore during the decennium 1901 to 1910 and ratio per cent of them that were registered and recorded by the Commissioners.

Year.	Number of deaths.			Actual mortality per mille.	Percentage of total deaths.	
	Actual.	Returned by the register.	Recorded by the Commissioners.		Registered	Recorded by the Commissioners.
1901	Not known	595	1344	...	...	...
1902	" "	518	1353	...	...	...
1903	1486	502	1172	34·39	33·7	78·7
1904	1323	370	1061	29·83	27·9	80·2
1905	1652	439	1246	36·29	26·5	75·4
1906	1597	422	1183	34·19	26·4	74·1
1907	1944	514	1380	40·55	24·4	70·9
1908	1476	310	..	30·30	21·0	...
1909	1450	Register transferred to the Commissioners on 1st June 1909 ...		28·70	...	...
1910	1140*			27·9	...	...
Average ...	1508	459	1248	32·22	26·7	77·9

* Excess in the preceding table is due to wrong entries in the register.

The matter being represented to the Government ended in the transference of the register from the Police to the Commissioners of the Municipality with effect from the 1st June 1909.

Since that date the register is practically recording all deaths as will be evident from the figures for the year 1910 in the above table; I say practically, the reason for which will follow.

The conditions which enabled me to attain to this numerical accuracy are as follow:—

1. Filling in the register from the books (now sub-registers under section 348, Bengal Municipal Act), kept at the two places of disposal within the town and the registers kept at those in Calcutta.

The former deficiency was evidently due to the Registrars, *i.e.*, the Police Inspectors depending entirely upon the people to report the events directly to their offices; not only was no account taken of the bodies disposed of in Calcutta, but the returns fell short of the number of deaths in the town that were disposed of at the two local places as will be evident from the following table.

Number of deaths.	1903.	1904.	1905.	1906.	1907.	1908.	Average.
Recorded at Cossipore Burning Ghat ...	572	458	502	452	546	367	483
" " Saharbangla Burial Ground ...	238	250	333	322	363	281	298
Total number of bodies of the town disposed of at the two local places ...	810	708	835	774	909	648	781
Returned by the Register	502	370	439	422	514	310	426

2. Prohibition of cremation and interment in any place within the town other than the two registered ones.

3. Absence of such places in the vicinity of the town except in Calcutta.

Since the closing of a burial ground in Calcutta which was resorted to for burial of the low-caste Hindus, of 'Sadhus,' etc., and of Hindu infants amounting to about 8 per cent of the total deaths, though such cases are being disposed of by cremation, some are taken to a burial ground at a considerable distance in the South Dum-Dum Municipality where no book is kept, and though people do come to the office to report such cases and though no pains are spared to see that none of these escape registration yet it is hard to be sure of it.

Causes of deaths.

If the register was defective in quantity, it was no less so in quality. Even now though it returns practically the actual number of deaths, a heavy figure, it gives us little idea about the extent and intensity of the ravages of the different preventible diseases, their relative share in the toll of victims carried off every year. As every one knows, the causes entered in the register are very rarely diagnoses of qualified medical men even when the deceased were treated by them; they are, as a rule, guesses of the relations and friends of the deceased or suggestions of the moherer or Munshi at the place of disposal or, at best, findings of the quacks whose medical knowledge is very indifferent.

So with a view to ascertaining the actual causes, I follow up the daily reports with prompt enquiries. As the work takes up much time, I have an assistant for it, the Sanitary Inspector who passed all the subjects of the second L. M. S. Examination of the Calcutta University except Pathology and who has a fair knowledge of medicine. A few of the cases are found to have been seen by us during life and some others, treated by qualified medical men; in these, our work is easy enough. But in by far the larger number of cases, we have to make local investigation, *i.e.*, we call at the house of the deceased, find out such of the

relations or friends as actually nursed him in his last fatal illness and make them relate the history of the case, its duration, course and symptoms and previous health, avoiding leading questions till they have finished their own account and then only a few such questions are put to clear up doubtful points. Leading questions put incautiously at the start and a large number of them put at any stage of enquiry only confuse the informants and lead to wrong replies Such investigation is made at once on receipt of the report in case of deaths entered as due to infectious causes or acute fever of very short duration; in other cases, it is made with as little delay as possible, *i.e.*, while the impressions about the illness are still vivid in the minds of the attendants. For diagnoses arrived at in this way one cannot claim infallible accuracy; still in most cases, the accounts elicited are clear and definite.

In course of the last five years as many as 6,320 cases were enquired into with the following result:—

Result of investigation into the causes of deaths in the Cossipore-Chitpore Municipality during the quinquennium 1907-1911.

Cause as registered.	Causes as ascertained by local investigation.	Cases found to be due to													Percentage of correct entries.					
		Fever.							Respiratory diseases.											
	Number of cases investigated.	Malaria.	Typhoid fever.	Undiagnosed fever.	Plague.	Small-pox.	Cholera.	Dysentery.	Phthisis pulm.	Pneumonia.	Other respiratory diseases.	Injuries.	Other causes.	?	1907.	1908.	1909.	1910.	1911.	Average.
Fever	2,117	256	234	80	14	...	21	274	183	416	124	...	398	117	9·9	10·5	6·1	19·1	16·2	12·2
Plague	40	...	...	1	37	...	...	1	...	...	...	...	1	...	100·0	100·0	83·3	100·0	92·8	92·5
Small-pox	245	...	1	...	...	242	...	...	...	...	...	...	2	...	93·3	100·0	100·0	100·0	50·0	98·7
Cholera	776	5	3	1	3	1	720	9	5	...	1	...	16	12	91·2	98·2	90·1	91·2	93·3	92·8
Dysentery and Diarrhœa ...	700	4	2	1	...	...	1	497	6	2	2	...	137	48	89·5	79·1	75·4	62·1	66·2	71·c
Respiratory diseases	796	8	5	...	1	...	...	9	199	177	256	...	144	17	80·4	80·8	77·4	73·4	74·7	76·8
Injuries	94	...	...	...	...	...	...	...	...	...	...	94	...	...	100·0	100·0	100·0	100·0	100 0	100·0
Other causes	1,552	59	8	3	1	5	15	41	17	32	23	...	1,129	219	81·0	59·5	61·4	91·6	68·1	72·1
Total investigated ...	6,320	332	253	86	56	248	757	831	390	627	406	94	1,827	413						
Percentage of investigated cases found to be due to.	...	5·3	4·1	1·4	0·9	3·9	10·7	13·2	6·4	9·9	6·6	1·6	28·9	6 8						

We find that while according to the register and books kept at the places of disposal, mortality in Cossipore-Chitpore during the quinquennium 1907 to 1911 was as follows :—

Year.	Mortality per mille according to register, etc., due to									Percentages due to							
	Fever.	Plague.	Small-pox.	Cholera.	Dysentery and Diarrhœa.	Respiratory diseases.	Injuries.	Other causes.	Total.	Fever.	Plague.	Small-pox.	Cholera.	Dysentery and Diarrhœa.	Respiratory diseases.	Injuries.	Other causes.
1907 ...	15·68	0·18	1·32	7·09	3·67	4·13	0·44	8·02	40	38·6	0·1	3·3	17·7	9·0	10·4	1·2	19·7
1908 ...	11·97	0·14	1·13	4·06	2·92	3·15	0·38	6·55	30·30	39·9	0·4	3·8	13·5	9·7	10·5	1·3	20·9
1909 ...	9·96	0·25	3·85	2·12	2·45	3·14	0·48	7·93	30·18	33·0	0·8	12·7	7·0	8·1	10·4	1·5	26·2
1910 ...	5·59	0·04	0·02	2·57	4·23	5·39	0·58	10·57	29·00	19·3	0·2	0·1	8·9	14·5	18·5	2·0	36·5
1911 ..	8·64	0·29	0·04	2·98	3·38	4·37	0·44	8·14	28·48	30·3	1·0	0·1	10·5	12·6	15·4	1·5	28·6
Average	·10·37	0·18	1·27	3·76	3·37	4·03	0·46	8·24	31·68	32·7	0·6	4·0	11·9	10·6	12·7	1·4	26·1

The actual mortality from the different causes as ascertained by checking the diagnosis in the register by local investigation was as shown in the following table :—

Mortality from different causes in Cossipore-Chitpore during the quinquennium 1907 to 1911 as ascertained by local investigation.

MORTALITY PER MILLE** OF ESTIMATED POPULATION.

Year.	Infectious diseases. Malaria.	Typhoid Fever.	Fever undiagnosed.	Plague.	Small-pox.	Measles.	Cholera.	Dysentery.	*** Tuberculosis: Phthisis Pulmonalis.	*** Tuberculosis: Other forms.	Acute Lobar Pneumonia.	Other Infectious diseases.	Total of all infectious diseases.	All other causes. Other Respiratory diseases.	Other diseases.	Injuries and Poisons.	Undiagnosed ?	Total.
1907	1·9	1·0	1·2	0·5	1·3	0·4	9·0	6·2	2·3	0·0	5·1	1·8	30·7	2·9	4·3	0·4	2·2	40·5
1908	1·7	1·5	0·0	0·3	0·8	0·3	4·7	4·3	1·5	0·0	3·3	1·3	19·7	2·4	5·1	0·3	2·3	29·8
1909	0·8	1·0	0·2	0·3	3·8	0·1	1·9	3·1	1·8	0·0	3·8	1·2	17·5	1·5	5·8	0·4	3·5	28·7
** 1910	1·6	0·8	0·3	0·0	0·0	0·6	1·9	2·9	1·7	0·0	1·8	0·9	13·5	1·4	4·4	0·6	4·7	23·6
1911	1·9	1·4	0·3	0·3	0·0	0·1	2·7	3·2	2·1	0·0	2·7	1·9	16·6	1·7	6·4	0·4	2·3	27·4
Average ...	1·6	1·1	0·4	0·3	1·2	0·3	4·1	3·9	1·8	0·0	3·4	1·4	19·5	1·9	5·2	0·4	3·0	30·0

PERCENTAGE OF DEATHS DUE TO

Year.	Infectious diseases. Malaria.	Typhoid fever.	Undiagnosed fever.	Plague.	Small-pox.	Measles.	Cholera.	Dysentery.	Phthisis Pulmonalis.	Acute Lobar Pneumonia.	Other Infectious diseases.	Total Infectious diseases.	All other causes. Other Respiratory diseases.	Other diseases.	Injuries.	Undiagnosed?.
1907	4·7	2·5	3·0	1·2	3·2	0·9	22·2	15·3	5·7	12·6	4·4	75·7	7·2	10·8	0·9	5·4
1908	5·7	5·2	0·0	0·9	2·6	1·0	15·8	14·4	5·1	10·8	4·4	65·9	8·7	17·5	0·8	7·7
1909	2·9	3·6	0·5	0·7	12·9	0·2	6·5	10·6	6·1	18·9	4·2	61·1	5·3	20·8	1·5	12·1
** 1910	7·3	3·2	1·2	0·2	0·7	2·4	7·9	12·4	5·7	6·8	3·8	51·0	5·7	20·8	2·6	19·2
1911	7·0	5·2	1·2	1·2	0·1	0·4	10·1	11·0	7·9	9·9	6·9	60·9	6·4	22·8	1·6	8·3
Average ...	5·8	3·6	1·3	1·0	4·0	1·0	13·6	13·0	6·0	11·3	4·7	65·0	6·3	17·6	1·3	9·8

*Cases from the neighbouring towns entered in the register by mistake have been eliminated from this table.
**Calculated on population as found by enumeration in December 1910 preliminary to the Census.
***Other forms of tuberculosis, very rare:—
viz. Pott's disease = 1 in 1907, 1 in 1911.
Arthritis = 1 in 1908.
Scrofula = 1 in 1907, 1 in 1911.

1. Such important causes of death as Typhoid fever, Tuberculosis and Acute Lobar Pneumonia have no cognisance in the returns of the register.

Typhoid fever which accounts for about 3·6% of the annual deaths against 5·3% due to Malaria is as a rule shown with the latter disease under Fever, only about 7·5% being returned under other headings.

Tuberculosis which as Pulmonary Phthisis is steadily gaining ground in the bastis of the town and already exceeds Malaria in the number of its victims (1·8 per mille per annum against 1·6 per mille) is, when recognised as such, returned with Pneumonia, Bronchitis, Asthma, etc., under the heading 'Respiratory' diseases of which it forms about 20%; while about 50% of its cases are entered in the register and shown in the returns as due to Fever.

Table showing distribution of deaths due to Phthisis under the different headings of the register returns during the quinquennium 1907 to 1911.

Year.	Mortality from Phthisis Pulmonalis per mille per annum.	Percentage of deaths from Phthisis Pulmonalis returned as due to					Percentage of deaths registered under respiratory diseases that were found to be due to Phthisis Pulmonalis.
		Respiratory diseases.	Fever.	Cholera.	Dysentery and diarrhœa.	'Other causes.'	
1907 ...	1·6	34·1	55·3	...	2·1	8·5	17·1
1908 ...	1·5	37·7	54·7	...	1·9	5·7	12·9
1909 ...	1·3	43·2	46·7	...	2·2	7·9	25·2
1910 ...	1·7	53·8	44·8	...	1·4	...	23·7
1911 ...	2·1	50·9	37·7	4·7	...	6·7	25·7
Average ...	1·6	43·9	47·8	0·9	1·5	5·9	20·9

2. Fever which, in this country, of course, means Malarial Fevers, is exaggerated largely at the cost of Typhoid fever, Dysentery, Phthisis Pulmonalis and Pneumonia.

Table showing the result of investigation into cases registered and recorded as fever during the quinquennium 1907—1911.

Year.	Mortality entered as due to fever.		Percentage of cases entered as fever found on investigation to be due to											Percentage of actual cases of malarial fevers returned under other heads.	Actual Mortality from Malarial Fevers.	
	Mortality per mille per annum.	Ratio per cent of total deaths.	Malarial fevers.	Typhoid fever.	Undiagnosed fever.	Small-pox.	Cholera.	Dysentery.	Phthisis Pulmonalis.	Acute Lobar Pneumonia	Other Respiratory diseases.	Other diseases.	Undiagnosed.		Mortality per mille per annum.	Ratio per cent of total deaths.
1907 ...	15·68	38·6	8·8	13·1	5·3	...	2·2	14·7	8·4	21·9	3·5	18·3	2·8	25·8	1·9	4·4
1908 ...	11·97	39·9	10·5	11·3	..	...	...	15·3	7·6	28·8	5·0	18·3	6·8	33·3	1·7	5·7
1909 ...	9·96	33·0	6·1	10·5	1·5	...	·4	14·5	8·6	27·2	...	11·0	19·4	32·6	1·0	2·9
1910 ...	5·59	19·3	19·9	8·3	3·5	...	1·6	10·5	9·7	10·2	3·6	26·8	4·4	12·2	1·6	7·3
1911 ...	8·64	30·3	16·6	14 9	3·6	...	·4	7·9	9·4	18·5	4·8	15·4	7·8	27·9	1·9	7·0
Average ...	10·37	32·7	12·4	11·6	2·8	...	·9	12·7	8·8	20·4	3·4	18·0	8·3	26·4	1·6	5·3

Fairly prevalent as the disease is, as is evident from the splenic index which last year was 11·5 per cent and from the high proportion which the cases of malarial fevers bear to the total number of cases treated in the out-doors of the local Hospitals and in the Municipal Charitable Dispensary, that the mortality from it should be so low is what could be expected,

(*a*) from the age constitution of the population;

(*b*) from facility for treatment, there being three Hospitals with out-doors and a Charitable Dispensary, private practitioners and a large number of quacks; and

(*c*) from the promptness with which the people apply for treatment as they can ill afford to be absent from work which means loss of wages.

3. As regards small-pox and cholera, information available from the register if complete is fairly correct; not only are the cases registered as due to them fairly correct including only about 1·3 and 7·5 per cent of other cases respectively, but of the actual number of deaths from them about 92·6 and 95·1 per cent respectively are registered as such. This is indeed as might be expected from the markedly characteristic signs and symptoms and dramatic course of the maladies.

4. While about 92·5 per cent of the cases registered as Plague are due to that disease, about 39·3 per cent of the actual number of deaths from it are registered under other headings specially as Fever.

Percentage of actual number of deaths from Plague, Small-pox and Cholera entered as such in the registers and records at the burning ghats and the burial ground.

Causes.	1907.	1908.	1909.	1910.	1911.	Average.
Plague	57·1	50·0	72·2	33·3	90·9	60·7
Small-pox	93·1	96·4	100·0	100·0	98·9	97·6
Cholera	95·2	100·0	97·7	91·2	97·8	95·1

5. Dysentery, an important cause of death, second in importance to Cholera only in this town, is counted together with all sorts of diarrhœas, so that apart from the fact that about 40 per cent of its cases are registered under the other heads (mostly under Fever), what figure is left to it conveys no definite information.

6. No account is taken of the other infectious diseases.

Deaths from 'Other infectious diseases' in Cossipore-Chitpore during 1907—1911.

Year.	Erysipelas.	Spreading traumatic Gangrene.	Septicæmia.		Pyæmia.	Tetanus.			Hydrophobia.	Diphtheria.	Whooping cough.	Cerebrospinal Meningitis.	Leprosy.	Syphilis.		Gonorrhœa.	Filariasis.	Total.	
			Puerperal.	Ordinary.		* Neonatorum.	Traumatic.	Idiopathic.						Congenital.	Acquired.			Actual number.	Mortality per mille.
1907	3	2	3	...	1	56	6	8	...	3	...	3	...	...	...	...	...	85	1·8
1908	5	...	6	...	...	40	2	2	...	...	...	2	2	...	...	...	1	60	1·3
1909	...	...	6	...	1	38	5	2	1	...	...	1	1	1	...	...	...	56	1·2
1910	...	...	4	...	2	30	2	3	...	2	...	...	1	...	...	...	...	44	·9
1911	5	...	14	4	3	47	5	3	...	1	1	...	2	6	3	1	...	95	1·9
Total in 5 years ...	13	2	33	4	7	211	20	18	1	6	1	6	6	7	3	1	1	340	1·4†

* Tetanus neonatorum accounts for about 19 per cent of total infant mortality.
† Average.

7 "Other causes" include.

Name of the disease.	1907.	1908.	1909.	1910.	1911.	Total.
1. Liver Abscess	...	6	2	2	2	12
2. Infantile cirrhosis of Liver...	10	8	15	14	17	74
3. Epidemic dropsy ...	...	...	2	3	...	5
4. Acute Rheumatism ...	5	4	4	4	1	18

The vagueness and inaccuracy of diagnosis obtain in a still greater degree in the case of infant deaths.

How unreliable the defective registers are as a source of scientific data for solving and demonstrating the problems of public health will be evident from the following facts.

1. Introduction of filtered water, though for drinking only, could be expected to reduce mortality from the filth diseases and therefore the total mortality as well. But had it not been for the register of the years 1889 to 1891 during which it was in the hand of the Municipal Commissioners, one would conclude from the official vital statistics that there was no such marked improvement of the health of the public and further the mortality had already been so low as scarcely to justify the expenditure.

Table showing mortality according to register total and from Cholera before and after introduction of filtered water.

Registering Agency.	Year.	Average mortality per mille per annum according to official register.		Remarks.
		From Cholera.	Total.	
Municipal Commissioners	1889 to 1891	7·98	39·35	Probably bodies, about one-third as many, disposed of at the out-of-way places in Calcutta were not registered.
Police ...	1892 to 1894	2·45	16·77	
	1895	3·97	21·19	Filtered water from the 1st April.
	1896 to 1898	1·97	15·73	
Municipal Commissioners	1909 to 1911	2·29	27·50	Register, from 1st June 1909, about complete.

2. According to the register, Small-pox returned a lesser mortality in this town than in the villages of the district, whereas, as a matter of fact, during the epidemic of the years 1906 to 1909, its ravages were worse here, the population consisting of a larger proportion of adults in whom the efficacy of Vaccination in the infancy had waned thus proving the necessity of compulsory re-vaccination as a measure to supplement primary vaccination so that the disease may practically be stamped out.

Table showing mortality from small-pox in the town and in the district excluding towns during 1905 to 1909.

Year.	Mortality from small-pox per mille of population per annum according to register.		Actual mortality per mille per annum in Cossipore-Chitpore.
	In Cossipore-Chitpore.	In 24-Parganas excluding towns.	
1905	...	0·01	0·11
1906	0·53	0·44	1·56
1907	0·49	1·02	1·32
1908	0·24	0·77	0·81
1909	1·57	0·93	3·82
1910	0·02	0·10	0·02

3. Whereas the register shows the course of Plague in this town to be erratic, the actual mortality shows that with adoption of anti-rat measures, circulation of leaflets on prevention and verbal instructions to the people since July, 1905, there has been a sudden and abrupt fall of the disease. The coincidence may be a mere accident, still it is remarkable.

Registration.

If the register of this town was defective, may we not reasonably doubt the accuracy of those other places, town and villages ? (1) That the entries in the cause column are unreliable goes without a question ; and (2) as regards completeness, it was equally defective in the other suburbs till the transference of the register to the Commissioners in case of two of them in 1909.

Mortality in the suburbs according to the register during the quinquennium 1906 to 1910.

Town.	Mortality per mille per annum.				
	1906.	1907.	1908.	1909.	1910.
Maniktolla	12·10	13·43	1·096	51·81	47·11
Garden Reach	19·17	20·83	16·83	36·27	46·65
South Suburban ...	29·19	30·82	21·72	14·14	24·26
Tolygunge	29·40	329·1	26·98	31·27	24·25

Under the circumstances, it will not be out of place if I make the following suggestions for improving the registration of deaths.

1. To ensure completeness :—

Part XI of the Bengal Municipal Act may be put into force in all Municipalities.

(1) The register of the towns may be cautiously transferred to the Municipal Commissioners under section 346 of the Act. They are more directly interested in the health of the people and it is highly desirable that they should have prompt knowledge of all deaths among them.

(2) Cremation and interment may be restricted under heavy penalties to the places registered under section 254 or, in case of villages, sanctioned for the purpose, a step as much necessary in the interest of public health as of registration.

Such places may be as few as possible, so situated as not to be a source of public danger and selected with due regard to the convenience of the people.

(3) The register may be filled from the books (sub-registers under section 347 in Municipal towns), that should be kept at all places of disposal, in towns as well as in villages and in which all particulars necessary for registration should be entered at the time of the disposal.

Any burial ground or burning ghat without sub-register in the vicinity of a town will militate against the completeness of its register.

(4) The registrar should report, for registration, particulars of bodies brought from the neighbouring circles to the registrars of those circles.

2. To have a correct record of the causes :

(1) The entries in the register may be checked by investigation by a medical man, by the registrar if he is one, and the vital statistics may be worked on the result thereof.

(2) The headings may be more definite.

The term Fever may be changed into Malarial fevers so that the registrars may not take it to mean all diseases with pyrexia as a symptom.

Dysentery may be shown by itself and not with diarrhœas.

(3) Tuberculosis is of sufficient importance to deserve a separate column.

(4) It will be interesting if deaths from all the infectious diseases be totalled and shown against those due to ' all other diseases ' and those due to ' Injuries and poisons.'

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VITAL STATISTICS, BENGAL.

AN INVESTIGATION INTO THE RECORDING OF VITAL STATISTICS IN A DISTRICT OF BENGAL.

By Charles A. Bentley, M.B., D.P.H., Special Deputy Sanitary Commissioner, Bengal.

In 1910 the Sanitary Board of Eastern Bengal and Assam drafted a scheme for the systematic investigation of morbidity and mortality in type areas, district by district throughout the province. The prime object of these "Test Enquiries" was to provide data regarding the actual causes of death, in the light of which it would be possible to assign a truer value to the mortality returns at present collected by the village chowkidars.

In the Dacca district the type area under investigation embraced the whole of the Keraniganj thana, which possesses a population of nearly 240,000 people distributed among about 1,100 villages. For this area a staff of three assistant surgeons and fourteen sub-assistant surgeons was employed. The method of investigation was as follows. Each sub-assistant surgeon was placed in charge of a certain number of villages. He was expected to make a house-to-house inspection of his circle, carefully enquiring into all causes of death reported by the village chowkidars, noting omissions in the return of births and deaths, and recording every case of disease brought under his observation during his visit. Each member of the staff was provided with a clinical thermometer, a stethoscope, a liberal supply of quinine tablets (Government treatments) and a few other simple medicines, mostly in pill or tablet form; and in this way it was possible to combine definite remedial measures with a statistical enquiry. This method of work was specially selected in the hope that during the course of the investigation, the information obtained *post-mortem* by enquiry among the friends of deceased persons would be supplemented by actual observation of cases of serious sickness, by the trained medical men employed, who would thus be enabled to diagnose in a large proportion of cases during life the presence of a disease which might ultimately prove fatal.

In order to guard against malaria, each member of the staff was provided with a mosquito-curtain, and the taking of prophylactic doses of quinine was also insisted on; and as the water-supply of many of the villages is grossly contaminated it was found advisable to give each of the men a regulation aluminium water-bottle to enable them to carry a supply of boiled water with them during their rounds. With a view to insuring that the staff should have a clear knowledge of malaria, each outfit also included a strongly-bound copy of the text-book on malaria drawn up for the Indian Government by Major S. P. James, I.M.S.

Work was commenced in the Keraniganj thana on September 1st 1911 and closed in September 1912. During this period the staff investigated the cause of death in 7,849 cases, verified 10,318 births and saw 60,943 cases of sickness, giving treatment to a very large number of the latter.

An examination of the figures obtained up to the end of August 1912, affords evidence of the value of the enquiry. The following table shows some of the results of the investigation :—

Deaths reported at the thana from September 1st, 1911, to August 31st, 1912, compared with those recorded by the special staff of the Test Enquiry. Deaths recorded during September 1912 are not included.

	Reported at thana.	Reported by special staff.
(1) Cholera	865	964
(2) Small-pox	361	350
(3) Fever	4,304	2,166
(4) Diarrhœa and dysentery	344	1,530
(5) Respiratory diseases	60	910
(6) Total	7,734	7,696

The discrepancy between the total number of deaths recorded at the thana and that reported by the special staff is due to the fact that in many cases deaths are not placed in the thana registers under the month in which they occur. Thus if a

chowkidar falls ill or dies, all the vital occurrences in his beat may remain unreported for several weeks or months, but when reporting re-commences they are pooled and recorded in the thana registers as if they had only just occurred

Of the 2,116 deaths recorded under the head "fever" by the special staff, 1,212 are reported as being due to malaria, 184 to enteric fever, 361 to measles, 3 to kala-azar and 406, undiagnosed fevers.

Of the 1,530 deaths ascribed to diarrhœa and dysentery, 1,012 were due to dysentery and 518 to diarrhœa.

Of the 910 deaths from respiratory diseases, 323 were due to phthisis and 319 to pneumonia, and 268 to other respiratory diseases.

The following table is of considerable interest:—

North and South of Keraniganj thana compared.

—	Population.	Spleen index.	Total deaths (September 1911 to August 1912 inclusive).	Rate per 1,000.
South	112,000	0·8 *per cent.*	3,778	33·7
North	128,000	25·0 „	3,918	30·6

The south of the thana which is very densely populated is an area of low-lying land separated from the northern portion by Dacca City and the river Boori Gunga. It is largely flooded during the rainy season and forms at this time a maze of khals and bheels. Contrary, however, to what might be expected there is very little malaria present there, the spleen index showing only 0·8 *per cent.* as compared to an index of about 25 0 *per cent.* for the northern portion of the thana, a large proportion of which is well above flood level. It is villages upon the high land especially which show a high spleen index; but in many cases where the spleen is high the rate of mortality is comparatively low.

A comparison of some of the principal causes of death in the two areas appears to indicate that gross contamination of the water-supply in the low-lying portion of the thana is the principal cause of the greater prevalence of dysentery and diarrhœa in the latter area:—

	South of thana.	North of thana
Malaria	193	1,019
Enteric fever	154	30
Cholera	485	479
Diarrhœa and dysentery	1,146	384
Respiratory diseases	454	456

In the south of the thana only 5 *per cent.* of the total deaths were due to malaria, but in the northern portion 26 *per cent.* were ascribed to this cause.

A comparision of the cases of sickness observed in the two different areas is also of interest.

Of the total of 57,554 cases of sickness recorded from September to August, 13,474 were reported by four sub-assistant surgeons working in the densely populated southern area and 44,080 by ten sub-assistant surgeons working in the more sparsely populated northern area. The details of some of the principal diseases observed are given below:—

	South of thana.	North of thana.
Measles	448	194
Cholera	47	108
Fever (including spleen)	1,308	20,346
Diarrhœa and dysentery	1,795	2,901
Respiratory diseases	646	1,655
Worms	1,797	2,743
Skin diseases	2,974	7,944
Goitre	564	66
Venereal diseases	187	620

In the course of the enquiry a number of important points have been brought to light. As is customary in India the village chowkidar is responsible for reporting vital occurrences in Eastern Bengal. The beat of each chowkidar includes from 75 to 100 houses or *baris*. There is a duffadar over every 30 chowkidars, and the president of the chowkidari unions also exercises some control over them.

The chowkidars are supposed to visit every house in their beat at intervals; once a week or once a fortnight in the case of outlying districts they attend the chowkidari parade at the thana police station; and they give in their reports of vital occurrences on this occasion.

The pay received by chowkidars is so low that they are obliged to add to their income in other ways, and they usually hold and cultivate land. It is also not an uncommon occurrence to find a chowkidar whose own house is in a village some miles from his legitimate beat. Under these circumstances there is no certainty of the men visiting the different portions of their beats with any regularity; and in many cases they appear to rely upon gaining their knowledge of births and deaths by enquiry among the villagers who attend the weekly bazaars. As it is an exception for a chowkidar to be literate the entries in their hathchittas are usually made by the duffadar or panchayat or in some cases at the thana police station itself. Many of the men too are comparatively aged and have impaired memories for recent events. Some chowkidars have been met with who were unable to remember if a birth or death had occurred in their beat during the preceding week, fortnight or month. This being so there is little chance of the returns of vital occurrences being accurate. During the investigation it was found that omissions on the part of the chowkidars to record births numbered about 6 *per cent.* of the whole, and about 4 *per cent.* of deaths were not recorded. These figures, however, give a false impression because at the beginning of the enquiry a much larger proportion of omissions were detected. But later on the chowkidars became much more careful in their reporting and many deaths and births which they had at first failed to note were subsequently recorded by them, sometimes a very long time after they had occurred.

There are other grounds also for believing that ordinarily a much larger percentage of omissions occur in the registration of the births and deaths. The more ignorant and superstitious among the villagers have a great dread of reporting the occurrence of a birth, as they fear that their doing so may lead to the death of the child; and they will often actually deny that a birth has occurred, especially when a death has recently taken place among the family. The analysis of the age periods at which deaths occur shows that frequently almost as many deaths are recorded among children aged 1—5 years as among infants. These facts suggest the possibility of many births, and deaths among young infants, going unreported.

Unfortunately the sub-assistant surgeons employed on the enquiry had to cover so great an area that to conscientiously visit every house in their circles would have taken them about two months, and this fact probably led to a failure to detect a considerable number of omissions. It is probable that more accurate figures would be obtained in future enquiries by limiting the number of houses in each circle to about one thousand which would represent a population of about 5,000 to 6,000 people.

As regards the classification of the causes of death the investigation shows that in the district examined the only returns of any value are those relating to cholera and small-pox. The heading "fever" as is well known is absolutely misleading and about as useful as that of "all other causes". But this is not entirely the fault of the village chowkidar. His own reports are frequently much more informing than those that eventually filter through to the authorities; and with a little trouble might be made exceedingly valuable. There are commonly understood terms for many easily recognized diseases current among the villagers in every district; and until driven into the routine method of reporting deaths as due to "fever," "cholera" or "small-pox" the chowkidars make frequent use of them. Sudden deaths are often reported as *thabra* or "thapti mara" literally "a sudden blow"; *tetanus resnatorum* as *pachoa paoa*, literally attacked by a ghost; and measles, phthisis and pneumonia are often indicated by special names such as *bappi*, *koi* and *bath sleshwar*. But when

the daroga or writer constable at the thana police station receives such reports they usually go down in his register under the heading "other causes" merely because such terms are not used in the schedule.

Observations made during the course of the investigation appear to show that it would be possible to improve the existing system of registration without great difficulty. Under the existing system all vital occurrences are pooled at the thana police station and the civil surgeon or other district officials cannot get detailed information without special enquiry; even then it is not an easy matter to get accurate figures for the various unions, and it is still more difficult to get figures for individual villages.

But if a register were kept in which each union in a thana was given an initial A.B.C., etc., and each chowkidari beat in the union was assigned a number A-1, A-2, A-3, etc., and all entries were recorded by beats and unions, it would be possible to immediately locate peculiarities in the returns, especially high or excessively low mortalities. As the numbers of houses in each beat are known, it would be a very simple matter to gauge from this register the approximate mortality rate of every portion of a thana.

By collecting for each district the current names in common use for a number of diseases, inserting them in the vernacular schedules, and giving special instructions that the chowkidars should be ordered to report all deaths from these causes, it would be possible also to greatly increase the value of the present returns.

It is possible however that a scheme for keeping special registers in each union, utilizing the services of the panchayats, village patwaris (where they exist) or village schoolmasters, for the purpose, might give good results. Village schoolmasters are particularly well placed for obtaining information regarding vital occurrences independently of the reports of chowkidars, so that they could easily exercise a check upon the registration of vital occurrences; and in connexion with the attempt to teach elementary hygiene in the schools it might be a useful measure to interest them in such matters.

Finally the importance of more careful registration of the total number of deaths occurring must be strongly emphasized. Each year sees an increasing demand for an extension of measures of sanitation, but in the absence of accurate recording of vital occurrences there is a grave danger that instead of finding improved sanitation result in a diminished death-rate, we shall actually see an apparent increase of mortality taking place. In the case of municipalities in Eastern Bengal death registration is a mere farce. In Chittagong town an investigation in 1911 showed that 35 *per cent.* of the deaths went unrecorded; and in Dinajpur town in 1912 enquiry has shown that 40 *per cent.* of the deaths occurring during the first six months were not reported. In the face of the facts it would appear that improved registration both for urban and rural communities is the most urgent of all sanitary reforms.

CIRCLE.—KERANIGANJ THANA.

Monthly statement of death according to age

—	Infants.	1—5.	5—10.	10—15.	15—20.	20—30.	30—40.	40—50.	50—60.	60—upwards.	Total.
September 1911	86	71	26	16	19	38	20	32	25	35	368
October ,, ...	137	151	45	14	30	50	25	33	27	64	576
November ,, ...	211	228	59	21	47	76	73	40	58	88	901
December ,, ...	247	285	83	27	69	110	68	45	56	102	1,087
January 1912	260	164	40	14	28	80	58	29	40	60	773
February ,, ...	220	141	55	6	22	52	36	46	27	68	673
March ,, ...	217	183	74	22	31	85	44	43	37	64	800
April ,, ...	175	227	72	26	41	78	41	37	34	63	794
May ,, ...	158	165	39	21	29	53	38	28	30	46	597
June ,, ...	133	123	25	11	12	25	18	18	26	40	431
July ,, ...	91	98	37	12	16	23	26	20	15	62	398
August ,, ...	93	81	26	14	7	25	21	13	23	25	328
Total ..	2,023	1,915	581	204	351	695	458	384	398	717	7,726

KERANIGANJ THANA.

Monthly statement of deaths according to disease.

—	September 1911		October 1911.		November 1911		December 1911		January 1912.		February 1912		March 1912.		April 1912.		May 1912.		June 1912.		July 1912.		August 1912.		Total.		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Total.
Cholera	1	1	7	9	61	84	100	117	47	49	22	24	93	74	85	106	32	31	3	4	5	2	2	5	458	506	964
Small pox	2	3	4	1	5	4	5	4	10	8	19	29	23	19	35	32	29	25	18	28	16	12	10	9	176	174	350
Chicken-pox	..	..	..	1	..	..	..	..	..	..	..	1	1	4	..	..	1	2	..	..	..	..	..	..	2	8	10
Measles	..	..	1	..	3	11	12	10	8	9	27	14	28	14	45	28	33	27	16	27	16	16	12	6	201	160	361
Malaria. Remittent fever..	9	3	4	5	15	9	12	23	11	16	9	12	12	8	9	5	19	7	10	3	7	7	7	3	124	101	225
Malaria. Intermittent fever.	23	20	40	24	16	20	18	16	6	18	7	13	12	11	10	14	12	19	10	18	15	6	11	11	180	185	365
Malaria. Spleen	33	25	42	37	49	32	42	41	28	27	18	19	31	22	26	16	20	22	18	10	23	16	17	15	342	280	622
Jaundice	..	..	1	1	..	1	1	2	..	..	8	..	..	..	..	1	..	2	1	..	2	1	..	..	8	8	16
Dysentery	36	15	48	50	56	70	61	81	60	56	57	44	46	29	52	89	26	31	24	24	24	28	26	30	515	497	1,012
Diarrhœa	9	8	13	23	17	30	36	45	38	31	24	31	16	28	22	28	20	24	14	23	7	11	12	10	228	290	518
Enteric fever.. ..	4	1	3	2	18	10	16	15	11	8	4	12	12	8	8	4	6	2	10	8	6	7	8	2	105	79	184
Kala azar	..	..	.	.	..	.	1	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	1	..	3	..	3
Beri Beri	..	.	..	..	.	..	..	..	..	..	..	..	..		..	..	..	..	..	..	..	..	..	..	..	..	..
Epidemic dropsy ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Plague	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Other fevers	21	21	14	28	28	32	26	31	11	33	10	17	6	23	11	17	3	14	7	13	16	11	7	6	160	246	406
Tubercle	5	3	13	6	24	17	29	14	20	8	18	17	20	10	17	8	22	6	12	8	17	9	14	6	211	112	323
Pneumonia	11	5	7	7	13	18	15	8	17	10	11	17	22	29	18	16	14	7	18	11	18	9	9	0	173	146	319
Other respiratory diseases.	7	9	7	13	13	13	23	18	14	8	12	8	14	12	9	12	9	6	15	7	14	5	12	8	140	119	268
Anaemia	1	..	..	..	1	..	2	..	..	2	..	2	..	2	2	1	..	..	..	..	..	..	..	..	6	7	13
Injuries	1	..	..	..	1	1	1	1	1	..	1	2	2	2	..	..	1	..	2	1	3	..	..	..	13	7	20
Poisons	.	..	..	..	..	..	..	1	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	2	3
Labour	.	10	..	5	..	5	..	10	..	7	.	3	..	6	..	4	..	6	..	1	..	3		1	..	61	61
Other causes	50	35	98	64	94	120	117	124	109	90	88	78	95	64	61	54	66	48	47	80	34	31	35	21	894	759	1,653
Total ..	213	157	30 2	276	414	477	516	559	392	381	330	348	432	365	410	383	314	279	220	211	228	174	183	142	3,949	3,747	7,696
	370		578		891		1,075		773		673		797		793		593		431		397		325				

PART IX.

EDUCATION AND HYGIENE.

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

POPULAR EDUCATION IN PUBLIC HEALTH

BY

MAJOR T. G. N. STOKES, I.M.S.,

Sanitary Commissioner, Central Provinces.

It has been said very truly that sanitation in its full meaning consists of two distinct things, *viz.*, 1. General Sanitation, and 2. Personal Hygiene. The first of these is a matter of money and is being slowly but surely dealt with on fixed lines as far as towns at least are concerned, and probably another ten years will witness enormous improvements in this respect, but the question of how to approach the problem of ignorance and apathy more directly than by waiting for general education of the people to have effect, is a much more difficult one, and it seems that we require to consider some outlines for initiating a definite policy. There are numerous Acts, Codes and Rules in existence, but they too often remain in the hands of the few and being of a not very interesting nature to the general public, there is no incentive to them to acquire knowledge of their meaning, or indeed, of their existence.

I have no doubt that advances have been made in other provinces in many ways to try and disseminate knowledge and advice. In the large towns probably much has been accomplished and the leading people possess a fair theoretical knowledge of what ought to be done and the reasons for it. The ideas which suggest themselves in this note deal, however, with the less advanced and more backward places which possess no Health Officer. On inspecting a town I have made it a rule in the Central Provinces to try and meet as many of the municipal members as possible and discuss public health matters with them on the spot, asking them questions about their own quarter of the town in particular. Though they are extraordinarily willing to listen, and even ask questions, I regret to say their lack of information is often profound. One gentleman, whom I met recently, having had some demonstration of sanitary defects in his *mohulla* appeared to be growing weary—it was getting near his meal-time—so I asked him what his functions and duties as a member were and whether he found them very laborious, he simply replied "Committee *ka kam karta.*" His efforts began and ended at that. From this it is argued that if a tabular statement of the details of each *mohulla* and the points requiring supervision were put into each member's possession, he would at any rate be in a position to make himself useful and, in time, some idea of his responsibilities and *raison d'être* would germinate. Similarly with regard to school-masters, it would appear that if part of the education of school-masters were concentrated on hygiene, they would be in a position to recognise the importance of watching the health of their pupils which is an important matter, seeing that many epidemics spread from schools and that children form one of our great reservoirs of malarial infection. I would suggest therefore that it be made a *sine qua non* that school-masters should possess a knowledge of the rudiments of hygiene.

Lately a monthly medical inspection of all schools within municipal limits has been instituted in these provinces and co-operation between the medical and educational fraternities will doubtless be fraught with good results.

The school-master is in a position of considerable influence and even if he is not a keen hygienist, his influence as a public man would be valuable, but I regret to say his energies now sometimes take the opposite tack.

The book-teaching of hygiene to boys does not offer much hope; a boy will simply be crammed with book knowledge which is rapidly forgotten, and he is not likely, in my opinion, to produce any deep impression on his parents by retailing what to them will be mere fairy tales.

The introduction of hygiene as an optional subject for examination among older boys might with advantage be encouraged, but its general adoption would, I feel sure, be a fruitless attempt. Many methods have been tried for the promulgation of knowledge among the people, *e.g.*, pamphlets, posters, almanacs (illustrated) and lectures, but the practical teaching of school-masters and of influential men in towns and villages seems to offer a better chance of success than any of them.

Coming to the application of this matter to rural areas the two classes of men who have opportunities in this direction are policemen and vaccinators. The vaccinator has a large field and his training in sanitation is, I believe, undertaken in some places, but if a better class of man were employed generally and properly trained in the recognition of simple diseases and the principles of sanitation, he could be made of more practical use and would be better able to cope with the epidemic duty he is sometimes employed on. He could also instruct *kotwars* not to report hundreds of cases of measles and chicken-pox as small-pox.

A simple primer on village sanitation (modified from Doctor Banerji's book) is being prepared with the intention of supplying vaccinators with an elementary education on the subject.

Village vital statistics are registered at the *thana* by a policeman who is wholly ignorant of the subject he is dealing with, relying wholly on the *kotwar's* report and he must consequently be in a weak position when he finds he has to classify a disease such as "*jalandhar*" (dropsy), "*luh*" (heat-stroke), "*pasli*" (pleurisy) and numerous others under their required headings. A simple brief table of questions to be asked and of diseases in their true groups is being prepared which will be of help to him when in doubt.

Attempts have been made to popularise quinine, and also to make known a few facts concerning malaria, by pasting a leaflet of instructions in the *kotwar's* book in every village and the books are now issued in this way.

ALL-INDIA SANITARY CONFERENCE—MADRAS—NOVEMBER 1912.

THE MEDICAL INSPECTION OF SCHOOL CHILDREN IN INDIA.

BY

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The medical inspection of school children should form an essential part of the duties of all Medical Officers of Health, on account of its importance as a valuable asset to the national health and wealth of a country.

This has now been made compulsory in England (Education Act, 1907, and Circular by the Board of Education, 1908), and other European countries. The system there has been, and is working very satisfactorily, due, no doubt, to a great extent to the co-operation of the parents and the general public with the Educational authorities.

The system of having school medical officers ought to be started in India, now that the Government of India have found it opportune and necessary to promote the advancement of Elementary Education and Sanitation—two new epochs in the history of British India—by providing ample grants of money for both purposes, recurrent and initial.

Should the system be introduced in this country, in toto or in part? There are two points at issue:—

(1) Finance.

(2) Initial obstacles.

With regard to the question of sinews of war, such a scheme would not entail much expense, as in India nearly every big city and District Town have District Medical Officers and a couple or more of medical subordinates (Assistant Surgeons and Sub-Assistant Surgeons). Some cities and towns have Medical Officers of Health in addition, and more are to be appointed in accordance with the recent Government of India order. The Sub-Assistant Surgeons can manage the duty fairly well under proper supervision.

There cannot be much difficulty in urban districts, rural districts may be left out for the present.

A good beginning might be made with European and Anglo-Indian schools in India, and in a select number of Indian Elementary schools of the larger cities. If the results are sufficiently encouraging as, no doubt, they will be in course of time and under careful management, the system may then be extended to all India, at the discretion of the several local Governments, and to suit different local conditions and environment.

There would be little or no opposition from the European and Anglo-Indian schools. Nearly all such institutions have an auxiliary boarding section with a medical attendant, (honorary or paid) and a small monthly fee is levied from each intern pupil for medical attendance and drugs. As a rule, only the sick children come in contact with the Doctor and there the latter's duty ends. The day-scholars are left alone.

As to Indian schools the opposition would not be great either, judging by the way public hospitals and dispensaries and the services of qualified medical men are patronised by all communities at the present day, especially so in the larger towns and cities. Even with regard to sanitation a decided change for

the better can be noticed in India. Old ways and superstitions are gradually drifting before the steady march of sanitary progress and education.

An experimental scheme on a small and moderate scale, and on the lines similar to those adopted by the Educational authorities in England, should be started as early as possible.

At present, school-children, particularly in Indian Elementary schools, are congregated together under all sorts of conditions and often to overcrowding in buildings which are far from sanitary.

In many cases no precautions whatever are taken during outbreaks of infectious and contagious diseases. This condition of affairs is seldom, if ever, noticed by the Educational Inspectors. Further, there is no provision for giving such children lessons in simple hygiene.

The European schools generally keep up to a very fair standard.

The method of examination may be detailed as follows in a tabular form. The examination may be conducted twice a year at least.

MEDICAL REPORT.

INSTITUTION.

Name of Pupil...Age..........................

Standard or Class..

Caste, Religion or Nationality. } ....
Height..................................Weight..........................

Details :—

1. General appearance.
2. Eyes—vision in particular.
3. Ear, nose and throat.
4. Teeth.
5. Speech.
6. Mental condition.
7. Heart and circulation.
8. Lungs—any Tubercular diathesis, etc.
9. Deformities, due to Rickets, etc.
10. Skin.
11. Family history.
12. Personal history.

General Observations.—May be summed up as (*a*) Good health, (*b*) average health, (*c*) bad health.

Remarks by Teacher.—As to attendance and application at school, inclination towards sports and athletics.

Direction to Parents or Guardians.

(Sd.)..

Date *Medical Officer.*

In this way any defects, etc., are brought directly to the notice of the parents with proper advice as to treatment, etc., and the desirability and utility of the continuance of studies of such children, or otherwise.

Such a medical examination need not necessarily be the regular clinical examination of hospital routine. It would only be an observation of any defective conditions that are likely to be present, and a suggestion of the precautions necessary to remedy them. Further, the object is not to aim at a perfect standard of health but to help the children to attain and keep the best health possible at school and in after-life.

PART X.

RURAL SANITATION.

A NOTE ON THE SANITATION OF SMALL TOWNS AND VILLAGES BY THE HON'BLE KHAN BAHADUR SAYAD MEHDI SHAH.

I have, for two long years, been the President of the Municipal Committee of Gojra, and, throughout this period, I feel I have honestly been trying to learn the sanitary requirements of the locality, and to meet them as fully as I was capacitated to do. Thus I have gained an experience pertinent to sanitary affairs which, I believe, is of no small practical value. The field, which constituted the centre of my exertions, was of the roughest, and, so, I presume that the experience, it has offered me an opportunity to avail myself of, is none of the worst.

I will first speak of the village (Mehdiabad by name), and the several points that have to be brought into strong relief in this connection, are as follows :—

(1) There is but one well, a solid, substantial structure, carefully supplied with lime pointing, reserved here for drinking purposes, and, hence, unlike so many other places, all the collective care of the population is expended in keeping this single source in the best possible order. To preclude it from extraneous influences, which so invariably conduce to utter defilement, it has been encompassed by a big brick platform. This platform as well as the drains connected with it are clean washed every week, whereas particular pains are taken to debar small children and invalids of all description from polluting them with their presence at the spot. Even in religious garb it is hard for impurity to gain an entry. Rituals, like that of lighting a well, with a clay lamp on certain prescribed days, or throwing sweetmeats into it, have been discountenanced with fervour in favour of the deity of health. To enable the well to stand the drainage which it is subject to, it is for above three long winter months filled with canal water. This process not only enables it to give out an adequate supply; but also helps a great deal in cooling and refreshing the contents. The coolness thus secured practically obviates the necessity of ice, and exerts a most potent influence in the direction of the annihilation of water worms. To facilitate the extraction of water, every side of the well is supplied with its own pulley, a bucket and a rope. These are never allowed to be displaced by private ones of bad make, and are always renewed at the very first sign of decay.

(2) The roads are kept in a perfectly trim condition, with all their depressions carefully filled up, so that we have naught of putrefaction there even in the season of the heaviest rains. The responsibility of sweeping them has been placed on the shoulders of the villagers themselves and every man has to see that the portion of the road in front of his house is properly broomed. Cases of neglect are reported by scavengers kept for general supervision, and brotherly exactions made in accordance with the degree of carelessness observed.

(3) Unlike so many other rural habitations, the houses here consist of two different apartments, one of which is devoted exclusively to domestic use, while the other is reserved for shutting the cattle up at night. To keep the passage of the air unobstructed, both of these rooms have been supplied with a couple of courtyards, standing face to face with each other, so that the air gets in at the one end, and out at the other, in a fraction of a second. Similar effective provisions have also been made for the introduction of a proper amount of light: the area confined to the use of the cattle is so fully exposed to the rays of the sun, that, in spite of the constant use that it is put to, it is possible to keep it from stinking at the expense of but little labour.

So much for the village, and now I must turn to the town.

I believe that it would hardly be a wonder if its present changed aspect should dissuade us from crediting any of the accounts given about its former thoroughly abominable condition. Verily, it was a succession of mounds, made neither of clay nor of sand, but of actual filth, the accumulation of generations. What could be done with a thing like that? The difficulty was, of course, very great; but, I found

a solution. I had the depressions dug to a still greater depth making them into tanks, big and small, according to the facility afforded and the clay taken out. This I spread in the gaps left between the mounds, so that the entire surface of the city was turned into a completely level plain interspersed with a number of quite beautiful reservoirs of water.

Next I looked to the construction of the roads and the drains. I did two *different things* with respect to the former—had them modelled on the plan of the back of a fish and provided permanent gangs of labourers to remetal any breakage of their surface as soon as made. This has proved highly useful in two respects. In the first place, it has prevented water from gathering together in small pits and thus adding to the unhealthfulness of the locality. In the second, it has helped in making mud, a common nuisance in many places, completely unheard of here. Even in the season of the heaviest rain we hardly hear of any slips and falls. I have also had the shisham trees, which ran in capital columns and clusters, on both the sides of the roads, and formed snug parlours and bowers of rare beauty for malarial germs, replaced by Eucalyptus trees. The dislodgment is well-nigh complete, and we are sure that the danger which suggested this measure will very soon shrink into nothingness. As regards drainage every street, as well as every lane, however insignificant and out of the way, has its own drains, which are kept and flushed with the utmost care. Even a festive occasion is not regarded as a sufficient excuse for observing the smallest possible amount of laxity in a direction like this. Again all the drains of the town are, by means of two big sewers, linked to a large tank, which is situated at a considerable distance from the town. The filthy water of the town, is, in its entirety, conducted to this structure, where a Persian wheel as well as an oil engine doles it out for agricultural purposes. Thus not only all kinds of putrescence and stinking has been guarded against, but even the obnoxious elements have been turned to the best possible account.

The question of the situation of the grave yards and factories confronted me next. Their closeness to the town could not but be fraught with the gravest possible apprehension. Perennial sources of unhealthiness, they also serve to generate superstitious ideas of the most questionable nature when suffered close to a village. But the people, who have developed a knack of thinking only of their immediate troubles, would not allow their removal to a distance. Poor ignorant people! they thought the arrangement tantamount to a very special addition to their troubles. Not even the slightest shade of the idea, that it meant but the digging of fewer graves, and a better and cheaper supply of factory-hands, entered into their mental attitude.

Then came the turn of the bathing tanks. Past experience had shown that stagnant water could develop into one of the worst pests, and had to be pumped out after every six months. To dispense with this periodical trouble, as well as to provide for the healthiest possible arrangement, I caused the neighbouring aqueduct to run through the tanks. This system, I need hardly mention, ensured a perpetual flow of water, the only remedy needed. There remained then the question of the surplus water. This was diverted into a big pool made for the purpose and was employed to serve two objects simultaneously, the growing of water- chestnuts, and the irrigation of the committee lawns and gardens. The latter process will soon be facilitated by the employment of a steam-engine, which is still in the course of construction.

One thing, being unquestionably of the very first importance, still remains to be mentioned. It is the question of a filtered water-supply. I have taken measures to have this done, and hope that the gap will very soon be filled up. In the meanwhile, arrangements identical to those at Mehdiabad, have been had recourse to and a single well, standing in the very centre of the town, has been taken for this purpose. The water supplied therefrom is so very cool and sweet that the only expectations we can rationally have from improved methods are a healthier, but not a pleasanter supply.

Such improvements can certainly be made in any place and if carried out I hope most of the innocent, useful, loyal lives, that have thus far been removed in batches, will remain available for the full natural term of years, and in their fullest vigour, to serve and adore our most benevolent and respected Government.

Rural Sanitation in Bengal.

PAST AND PRESENT.

By Moti Lal Ghosh, Esq., Calcutta.

The Past.

Salubriousness of former villages.

What was the sanitary condition of Bengal villages sixty years ago? As far as I am aware, no official enquiry has ever been held into this subject. The official and urban impression perhaps is that these villages were then as insanitary as, or perhaps more insanitary than, they are now. The reverse, however, is the case. This I say partly from my own personal experience and partly from official reports. I was born and brought up in a village in the interior of Jessore which was generally known as a fever-stricken district. Yet sixty years ago there was very little disease in it, and this was the case with most of the villages in Bengal.

It was in the months of September and October after the usual autumnal rainfall had ceased, that the people, as a rule, were attacked with fever. They fasted or lived on low diet for seven days and were completely free on the 8th, there being no relapse of the fever afterwards. That was the general rule. Those who had enlarged spleens, however, suffered from periodical attacks of fever throughout the winter but they usually shook them off as soon as spring with its southern breeze made its appearance. On rare occasions the fever would take a typhoid character and end fatally in most cases.

We had at that time plenty of mosquitoes but no malarial fever. Cholera was practically unknown. So were phthisis and other respiratory diseases except asthma. The dreaded small-pox now and then broke out in a virulent form, but the Tikadars or small-pox doctors treated the disease with wonderful success. What a pity that this race of specialists has now become extinct and that their treatment is lost to the world. The mortality in those days was necessarily small.

Village life.

Five or six decades ago there were very few towns or municipalities in Bengal. The pick of the nation lived in rural areas. The result was that the bulk of the villages were furnished with all the necessaries of civilized life. They had an excellent system of drainage; and each of them possessed at least half a dozen tanks, one or more of which were reserved for drinking water, unless it stood on a flowing river. No people were more cleanly; they rubbed their bodies with mustard oil and bathed at least once during the day. They lived in well-ventilated houses, facing south as a rule, and having large compounds. They had their disinfectants in cow dung. Fields were specially set apart, far from human habitation, for latrine purposes. The people had thus pretty a good knowledge of the hygienic laws.

They had abundance of food, and were good eaters. There was scarcely a family, however poor, who had not one or more milch cows. Rivers, channels, khals, tanks and ponds abounded in fish. Fruits were plentiful and so were fresh vegetables. Rice sold at one rupee per maund, and all kinds of cereals were also very cheap.

Villages in those days thus teemed with healthy, happy and robust people, who spent their days in manly sports—in wrestling and playing lathis and swords; in swimming and climbing up tall trees; in riding and running, not troubled by the bread question or the fear of being visited by any deadly pestilence. In short, the people could in those days nourish their bodies properly with wholesome food and drinking water; they could keep their villages dry by natural drainage; they had not to struggle hard for their bread; they had enough of grazing lands for their cattle and unsilted-up rivers to furnish them with such nourishing foods as milk and fish; they had also several other advantages they do not possess now, and this is possibly the main reason why they were able to enjoy an idyllic life, five or six decades ago.

Here I quote a letter, embodied in that interesting and useful brochure by the well-known Vakil of the High Court, Babu Kishori Lal Sarkar, entitled "A dying race: how dying," which purports to have been written by Lord Minto, grandfather of the late Viceroy, to show what a fine physique the Bengalees had one hundred years back. It is dated 20th September 1907 and His Lordship thus speaks of the Bengalee race:—

"I never saw so handsome a race. They are much superior to the Madras people, whose form I admired also. Those were slender. These are tall, muscular, athletic figures, perfectly shaped and with the finest possible cast of countenance and features. Their features are of the most classical European models with great variety at the same time."

But those fine specimens of humanity are now rarely to be found in Bengal.

The great Burdwan fever.

The deterioration of the race began with the outbreak of a kind of fever in an epidemic form in the sixties of the last century which is known as the "Epidemic" or "Burdwan" fever, and which has now converted itself into malaria and spread not only in this province but all over India. A commission under the name of "the Epidemic Fevers Commission," with Dr. Elliott as President, was appointed in January 1864 to enquire into the origin of this fell malady and we gather the following information from its report:—

"Everywhere it was spoken of by the natives (the people) as 'Nutan-jwar' (new fever) and became popularly known under the name of 'Burdwan fever'."

In Dr. Elliott's opinion, "from its being a new type, it (the fever) is not well understood." So it was "Nutan-jwar," that is to say, a new type of fever, which means that it did not exist in the province before.

The Commissioners could not accurately trace the place of the first outbreak of the epidemic. The only facts they could gather were these. A virulent kind of fever like that which destroyed Gour, now and then appeared in small localities in an endemic form. Such a disease depopulated a large and populous village named Gadkhali near Jhinkergacha, Jessore, in 1840. The next instance occurred at Ula in Nadia "at the commencement of the rainy season of 1856." It is said that the Gadkhali fever travelled to Ula; but, this is hardly possible, for not only was there an interval of 16 years and the distance between Gadkhali and Ula was fifty miles, but no other adjoining villages in Jessore were similarly affected. However, Ula may be regarded as the starting point of the first epidemic outbreak, for, from there, the Commission says, it visited Chagda next year and "extended along the east bank of the river in a southern direction down to Kanchrapara, Halisahar, Naihati and other places. It is called "the Burdwan fever," not from its first outbreak in that district but from its most virulently raging there.

Here is a graphic description of the "new fever" and how it carried off its victims, quoted from the report of the Epidemic Fevers Commission and which, we doubt not, will be read with horrid interest by the general public:—

"It (the epidemic fever) is essentially a congestive remittent fever, for the reason that the local organic congestions appear to be more marked and more formidable than are usually observed in the ordinary and less dangerous remittents of the country. During a first attack, the head is the seat of congestion. The eyes are bloodshot and aching, the face is suffused, delirium early ensues, and collapse, terminating fatally in from 36 hours to four or five days, closes the scene. Next in urgency to the cerebral symptoms we have to deal with a highly congested state of the thoracic viscera, and with great difficulty of breathing, the air tubes being loaded with mucus, and death finally resulting from asphyxia. The abdominal viscera do not appear to be so frequently implicated during the earlier stages, but they are almost invariably affected during the later period. The premonitory symptoms appear to be not well marked, but there is little doubt that for some time previous to the actual attack the patient is indisposed, though he seldom pays much attention to this warning.

The first stage is ushered in by an accession of febrile heat, preceded by only slight shivering, frequently by no sensation of coldness whatever. This heat rapidly increases, and the disease runs the fatal course we have described. Should the patient, however, escape this deadly and urgent attack, the fever clings to him with unabated violence from 15 to 25 days from the commencement of the attack. During this period many succumb and die from exhaustion. After the fifteenth day, however, remission or intermission takes place, and the heat of skin and more urgent symptoms disappear, leaving the sufferer in a dangerous state of weakness and exhaustion. This freedom from febrile excitement continues for some ten days, when the enemy again assaults him, and though this takes place generally in a less violent and deadly manner than at first, yet from previous suffering and exhaustion the enervated frame is less able than before to withstand the attack, and the result is often fatal. The second attack, as just stated, is in itself less violent than the first, and it is of far shorter duration.

The fever now assumes a well-marked intermittent type; it returns usually after an interval of fourteen days, at new and full moon, and clings with great obstinacy to its victim. Still, though the well-marked intermittent type has set in, with its three distinct stages of cold and shivering, hot dry febrile skin, and perspiration, yet it is not by any means unusual for the fever again to relapse into a well-defined remittent. Again, all types of intermittent are met with from the true tertian and quartan to fevers recurring at intervals of five and fifteen days; and, as a rule, few who have been seriously attacked completely shake off the disease until change of season has fairly set in, or until they remove from the locality. When the disease has become chronic, and has assumed the intermittent type, enlarged spleens are the general rule. With this the liver also is frequently enlarged and congested and the intestines are more or less implicated, chronic diarrhœa and even dysentery being no infrequent sequelae. Anasarca and a general anaemic and emaciation are more or less seen in all these chronic cases, and the fatal result is, in the case of the majority of these debilitated wrecks, a mere question of time."

Is it Malaria?

All these symptoms are not those of malarial fever which now prevails throughout India. It is for medical men, and not a layman like myself, to find out whether there is any connection between this "Burdwan fever" and what is known as malaria. The popular belief is that the former having spent its first swift-killing fury in a few years, gradually settled down into a malarial type, which is however no less deadly in its effect, though slow in its operation.

Epidemic Fevers Commission.

In the muggy days of September 1860, between wet and heat, the epidemic began to rage violently and extend its progress from one, two and three, into groups of villages. In 1861 it broke out with redoubled force. The extent of its attack was widened westerly from Dwarbashini on the south to Burdwan on the north, and easterly as far as the villages in and about Baraset. The places most affected were Triveni, Halisahar, Kanchapara, and Goulpar, all populous villages or towns. In 1862 the fever-stricken area extended northwards between Katwa on the west and Meherpur on the east, and southwards between Dwarbashini on the one hand and Goverdanga on the other. In 1863 there was a slight abatement of virulence, but the monster went on extending its area to several unaffected parts of the country; and in 1864 a Commission, as stated above, was appointed under the presidency of Dr. Elliott to investigate the causes of this terrible pestilence. Here are the conclusions of the Commission:—

"We have been led to ascribe the prevailing sickness to (1) miasm, (2) polluted drinking water, (3) vitiated air and deficient ventilation, (4) the excessive use of farinaceous food, and (5) contagion to a slight extent."

Out of these diverse causes, they recommended that "our first object must be to reduce, as much as possible, the generation of miasm, or malarious exhalation arising principally from moisture in the soil during the drying process after the rains;

and any means by which this drying process can be accelerated and shortened will produce a 'pro tanto' diminishing effect on the total amount of miasm generated. To effect this object the obvious course is to improve the drainage of the country obstructed by the silting up of rivers and khals, and the general assimilation of levels which have gradually taken place of late years. Remembering that the direction of the natural drainage of the villages situated along the river banks is *inland*, we have no difficulty in believing that it is impeded by the Railway embankments on both sides . . . . With a view to improve the internal drainage of the villages, we would strongly recommend the construction of open water-ways to carry off the surface water directly to any neighbouring river, khal, or beel that may be available, or failing such to some one or more low pools or tanks outside the village."

In the opinion of Drs. Lyon and Saunders as well as Colonel Haig who were members of the Commission, increasing poverty of the people was also one of the causes of the disease, and they recommended stamina-improving food. It was to Raja Degumbar Mittra, the Indian member of the Commission, that we owe the theory that "impeded drainage" was a most powerful agent in the causation of the fever and this is now universally admitted to be a correct theory. Thus all or most of the known causes which bring about malarial fever were discovered, but, alas, none of the recommendations of the Commission were carried out, with the result that Bengal is now under the iron grip of a monster which is ruthlessly decimating its fairest district and unchecked and unresisted.

The Present.

Within the last sixty years malaria and cholera have swept away tens of millions of people from Bengal. Those who have been left behind, generally speaking, are more dead than alive. Enter any village you choose and the silent homesteads and the dilapidated houses—many of them originally palatial buildings—proclaim the sad fact that it was at one time inhabited by a prosperous population, three-fourths of whom are dead and gone. It is desolation from one end of the village to the other!

Previous and present Burdwan.

The devastating pestilence which broke out in the sixties is called "the Burdwan fever", because, its havoc in that district was most terrible. And yet not only was Burdwan a sanitarium in Bengal before 1860, but one of the healthiest places in the whole of India. Dr. French, who made a special enquiry into the outbreak, thus speaks of the previous salubriousness of Burdwan in his paper on the subject:—

"Before the days of the epidemic the district of Burdwan was noted for its healthiness, and the town of Burdwan was regarded as a sanitarium. It was even customary for persons suffering from chronic malaria to go to Burdwan where cures of the disease were common."

Here is another extract from the same paper:—

"The census report for 1881 states that quarter of a century ago the district was considered one of the most salubrious in the province. If we turn to Hamilton's account of the district, we find that three-quarters of a century previous to the epidemic 'there were few villages in Burdwan, in which there was not a school in which children are not taught to read and write; there is no portion of territory in Hindustan that can compare with it for productive agricultural value, in proportion to its size; it appears like a garden surrounded by wilderness.'"

So, according to the census report of 1881, "a quarter of a century ago," that is in 1856, the district of Burdwan was "one of the most salubrious in the province." The same was also the sanitary condition of Burdwan three quarters of a century previous to the outbreak of the historical epidemic in 1862, that is to say, in 1787. And what is it now? In the census report for 12 years from 1862–74, the epidemic had carried off, as the "District Gazetteer" of Burdwan points out "not less than three-quarters of a million of persons." Dr. French estimated the total mortality at about one-third of the population in the tracts attached by the epidemic.

"*Very Mild*" *Endemic Malaria.*

Here is another extract from Dr. French's paper—

"It is possible that part, at least, of the epidemic was due to an epidemic manifestation of endemic malaria that doubtless existed in Lower Bengal before the days of the epidemic. It is easy to understand in the present day how endemic malaria became epidemic by the gradual silting up of the natural drainage outlets of a well-drained, healthy and prosperous tract of country. This must have occurred in Lower Bengal in the days of the epidemic, as Payne and Smith suggested in the seventies."

* * * * *

"The endemic disease must, however, have been very mild, before the days of the epidemic, in many of the places that were subsequently terribly affected, specially Burdwan."

Dr. French thus makes it plain that if endemic malaria existed in Lower Bengal, it must have been very mild, before the days of the epidemic of 1862, in many of the places that were subsequently terribly affected. He further observes that the country was well-drained, healthy and prosperous. The outlets of the natural drainage were, however, closed, and the mild endemic malaria broke out into a fierce epidemic in the sixties and desolated the province.

The disastrous effect of the outbreak.

To give an idea of the havoc which malaria has committed I shall describe the condition of my native village. Sixty years ago it was full of people, the bulk of them quite healthy. But what have we got now? In the place of one hundred Brahman and Kayastha families who then inhabited the place, we have now scarcely half-a-dozen left there. At the latter end of the sixties of the last century, malaria of a virulent type broke out in the village after a great flood, which kept it in a water-logged condition for many days, and carried off almost half the population in the course of two years. The virulence of the disease then abated, but it went on slowly killing the rest, year after year, till it has well-nigh depopulated the place. There were also in it about fifty families of Goalas and thirty families of Rajputs. All have disappeared with the exception of two or three! The whole village is now embedded in a dense-tangled mass of rank jungle and bamboo thickets, the abode of jackals and sometimes of leopards. Most villages in Bengal tell the same melancholy tale.

The dying race.

The Bengali race is thus dying out, and it must ultimately disappear like the old Greeks, who also fell a prey to this fell disease, unless vigorous steps of the right sort are promptly taken to save them from extinction. And other Indian races must follow suit. It has been officially admitted that, even in such of the foremost districts as Nadia, Jessore, Berhampur, Rajshye, etc., not only has the population decreased, but, as a rule, the death-rate is above the birth-rate. This must be the case; for, it is not possible for a malaria-stricken people, many of them mere skeletons, almost bent-down with the weight of their spleens and livers to grow and multiply. Our social census also shows that not only are higher but also lower caste people fast disappearing.

Terrible economic loss.

It should not also be forgotten that the increase of malaria is an economic calamity which robs a country of its most precious source of wealth. Celli sums up briefly and to the point: "Malaria annually costs Italy incalculable treasure." One of the most dangerous effects of malaria is that it makes people avoid all bodily or mental toil. Laziness and lack of enterprise being thus the marked characteristics of the unfortunate victims of malaria, each generation, as it is born, is subjected not only to the same physical surroundings as its predecessors were, but also to an unhealthy moral atmosphere. The supreme importance of the question cannot thus be over-stated. The very existence of the people and the empire is involved in it.

Pitiable condition of modern villages.

I need not dilate further on the point. It is an admitted fact that people are dying like flies from malaria. How to check its disastrous effects? Not only have proper remedies been suggested by the Epidemic Commission of 1864, but also by the Drainage Committee, appointed by the Government of Bengal in 1906 to enquire into the conditions of drainage in the Presidency Division and their connection with malaria as well by the Malaria Conference held at Simla in October 1909. I shall deal with some of the conclusions of the last two bodies.

The Drainage Committee justly say that the main factor in the causation of malaria is the extremely insanitary condition of the villages themselves. We have seen above what a Bengal village was like in pre-epidemic days of the sixties of the last century. But what is it now? "The thick jungle; the large number of tanks, pits and surface collections of water; the bad drinking water-supply; the promiscuous defœcation; the water-logging of the soil, owing to imperfect drainage, etc.," to quote from the Drainage Committee's report, characterise a Bengal village of the present day.

The description is far from complete. There is no longer a sufficiency of healthly food and good drinking water to enable the villagers to nourish their bodies properly and thereby keep out the germs of diseases. Food is scarce and healthy food absolutely rare. Where are our cattle? Almost all gone! And cow's milk, butter and "ghee" are our healthiest food. But they cannot be had now, in any appreciable quantity and in a wholesome condition, for love or money. The milk we take is so bad in quality that it does more harm than good. The water which millions of rural people drink is veritable poison. Almost every village is full of noxious jungle and weeds, and saturated with subsoil dampness. The fields which served the purposes of latrines no longer exist.

Thus the condition of things that existed six decades ago has been completely reversed. Water is not now, as before, drained away at the conclusion of floods or the rains by reason of obstruction to the drainage. The thick and interminable jungle, by standing in the way of ventilation and delaying evaporation, keeps the surface of the ground damper than would otherwise be the case. The general filth surrounding the houses which was unknown before, poisons the air and contaminates the sources of water-supply, which is getting scantier year after year: while bad drinking water induces bowel complaints and general debility, which, again, make the system susceptible to malarial attacks. Need any body wonder now why malaria and cholera have established themselves so firmly and are committing such havoc in this country?

Improvement of village sanitation.

The improvement of village sanitation, therefore, demands the first consideration of the authorities. What the Bengal Drainage Committee recommend is that "jungle round the houses should be cut down; the drainage of the villages should be improved by cutting surface drains and the earth removed used for filling the existing pits and hollows. Marshy areas and ponds should be drained or filled up or converted into clean tanks which do not breed mosquitoes. The question of good water-supply for drinking is important. All unnecessary tanks should be drained or filled in as far as possible, and those that remain should be kept clean and free from weeds."

The Simla Conferenee virtually suggest the same thing. In their opinion the best way of combatting malaria is to extinguish the anopheles species of mosquitoes and by the use of quinine. On this point I may have a few words to say later on.

Relation between poverty and malaria.

In the meantime I should point out that it is somewhat remarkable that neither has the Drainage Committee nor the Simla Conference discussed the question of the close relation between malaria and poverty. This was pointed out long ago by such distinguished medical authorities as Dr. Lyons and Dr. Saunders as well as Colonel Haig when they served as members of the Epidemic Fevers Commission in 1864.

Later on, in the seventies, Dr. Lethbridge propounded the same theory, alleging that the people having been under-fed and their physical system being thereby weakened, they became readily susceptible to the disease by losing their power of resisting the malarial poison. A recent Government Medical Report expresses this view in very pithy language, namely—

"Fever is a euphemism for insufficient food, scanty clothing, and unfit dwelling."

At the Simla Conference also, Major Christophers described eloquently how the mortality from malaria was the heaviest among those who were the poorest and lived in the greatest squalor. It goes without saying that, if the people are more prosperous they can feed, house and clothe themselves better and make effective sanitary arrangements for the protection of their health. The Drainage Committee and the Simla Conference might thus have very pertinently drawn the attention of the Government to poverty as a very important, perhaps the main, factor in the causation of the cruel scourge. I earnestly trust that the present Conference will be pleased to do so by passing a resolution on the subject.

Embankments and Malaria.

Then have protective and railway embankments and borrow pits anything to do with malaria? This question was also avoided by the Simla Conference though the fact cannot be denied that not only railway but other embankments as well as raised roads also obstruct the natural free passage of water; and obstructed drainage has been admitted to be a fruitful source of malaria. It is again a fact that borrow pits are the breeding grounds of mosquitoes and should not, therefore, be allowed to be made without providing for their drainage.

Rural drainage.

Now what is needed to remove human misery due to disease is to adopt those remedies about which there can be no two opinions. What are these measures? We shall confine our remarks to the rural tracts of Bengal. We need hardly say that drainage and water-supply claim the first consideration in improving our village sanitation.

Here is a remarkable fact. In pre-malaria days our villages had no raised roads or paths as now, but only what are called village tracks. They were quite good for our carts, drawn by bullocks. And these tracks served another good purpose. While the present-day raised paths obstruct the free passage of rain-water in the rural areas and make them water-logged, the former tracks presented no such obstruction but helped its natural course. In short, the drainage of all villages in Lower Bengal in those days was effected by the water first running into the nearest paddy-fields and thence collecting in the beels, from which it rushed through khals and canals into larger streams, which, again, communicated with navigable rivers. All this now practically is a thing of the past.

Rural drainage may be considered in four stages, namely (*a*) in the village sites themselves; (*b*) in the rice fields; (*c*) in the beels; and (*d*) in the khals communicating from them to the rivers and in the river channels themselves. The Drainage Committee observes in this connection: obstruction to the free flow of water may be caused by—

(*a*) pits and holes, raised paths, and jungle-choked channels which cause the water to accumulate in the village itself;

(*b*) by measures intentionally taken in order to retain the water up to a certain time upon the rice fields by means of small bunds; or

(*c*) by obstacles lying in the channels which should drain the beels into the rivers. These may either be artificial, such as fishing weirs, embankments impounding water, tanks dug in the bed of the Nalas, borrow-pits made by the Public Works Department or Railways, or roads, railways, and protective embankments crossing them; or natural accumulation of silt deposited by the water which enters the khals or rivers in times of flood.

So, not only should the villages be drained and rendered as dry as possible by removing all obstacles that stand in the way of the free egress of water, but they require many other sanitary improvements such as the lowering of the sub-soil water, the clearance of thick jungle, the filling up of useless tanks or ponds, and the supply of good drinking water.

Drainage Committee's allusion to railway embankments—borrow-pits.

The Drainage Committee alludes to railways and protective embankments as obstructing free drainage. It is to be regretted that the Simla Malaria Conference did not discuss this subject or suggest any remedy. But it must strike every man with ordinary common sense that, if there were more culverts with larger openings in railway and protective embankments, there would be very little obstruction to the drainage of the villages. So the remedial measure is to make it obligatory on Railway Companies and the Public Works Department to increase the number of culverts and thereby remove the obstructions to the free passage of water.

Rural water-supply.

The question of borrow-pits also need attention. That they are breeding grounds of swarms of anopheles mosquitoes is an admitted fact. That being so they must be prevented. We understand that, in the Madras Presidency, by a Government ruling, the Public Works Department is prohibited from allowing borrow-pits to be made within certain distances of villages, and their drainage is enjoined. Similarly, railway and general contractors may be restrained, by legislation if necessary, from making borrow-pits without providing for their correct drainage.

Water-supply is also a dire necessity to make Bengal villages healthy. The bulk of them annually present a heart-rending spectacle the like of which is perhaps to be witnessed nowhere in the world. Fancy myriads of people, during the hottest season of the year, have to drink not water but what may be more properly called diluted sewage; and many of them have to fetch this poison from a distance of one, two or three miles. The result is deadly cholera, diarrhœa or dysentery, and tens of thousands of villagers fall victims to them. Dirty water, again, creates mosquitoes, and thus indirectly brings about malaria. Previously rivers, streams, channels and tanks supplied the rural population with wholesome drinking water, but they are silted or choked up, and hence the abnormal dearth of water. Barring those villages which are on river banks, every one of them needs at least three tanks to keep its inhabitants in some state of health and comfort, namely, one for drinking, one for bathing and washing, and one for jute-steeping, purposes.

Jute.

Here is a blessing and a curse at the same time. Since the last few years jute has been fetching a good price and is thus improving the material condition of the ryots. But they and the general public residing in rural tracts have to pay a heavy penalty in this connection; the jute fields are breeding grounds of mosquitoes; secondly, the stench which jute-steeping produces is almost unbearable; and thirdly, jute is steeped in tanks and stagnant rivers and channels the water of which becomes absolutely undrinkable. Nay, more; jute-steeped water is a deadly poison to all kinds of fish; and last year a painful sight was seen by the inhabitants of my native village and numbers of other villages standing on both sides of the river Kapatakshi, which fifty years ago had a good current but is now stagnant and overgrown with moss and weeds, and whose water was then, as its name indicates ("Kapatakshi" means pigeon-eyed), as clear as the eyes of a pigeon but is now muddy and reddish—well, what these people saw was that all the fish it contained was dead and floating, and this was because of the steeping of jute in its water. The matter should engage the serious attention of the Conference.

Here is a suggestion for the consideration of the Conference. If borrow-pits could be converted into continuous sheets of water, not only would the breeding grounds of mosquitoes be destroyed, but they might also very well be utilised for the steeping of jute.

A request to the Conference.

What I would submit to the Conference is that the Government of Bengal may be specially requested to devote its close and undivided attention to the question of rural sanitation. This means the improvement of drainage, water-supply, clearance of jungle, etc.; in short, the restoration of the villages to their original condition as far as that is possible. The Bengal Drainage Committee's recommendation is to the same effect, though in a modified form. "It is not to be expected," to quote from the Committee's report, "that the villages of Bengal can all be turned into model villages immediately, but much can be done gradually, especially if the co-operation of the zamindars can be obtained." They further observe that "a few villages, here and there as object-lessons, would form useful experiments as to the value of the measures taken, and if successful, would go far to obtain that co-operation." It was an excellent suggestion, but has not been carried out as yet, though made half a dozen years ago, by competent authorities.

Sanitation first, education afterwards.

I do not draw upon my imagination when I say that the Bengali race is bound to disappear if our villages are not made habitable. This is no doubt a terrible fact, but it must be faced and the race rescued from its threatened doom. No one is a more earnest advocate of mass education than my humble self; yet I am compelled to say—sanitation first and education afterwards under existing circumstances. For, who would enjoy the blessings ot education if the people were dead or in a dying state? Education can wait, but not sanitation. Of course the better arrangement is for education and sanitation to go together, funds permitting.

No cause for despair.

There is however yet hope for Bengal. For, she has been blessed with a Governor—may His Excellency's shadow never grow less—who has already fully realised the supreme importance up rural sanitation. Lord Carmichael has already taken up the question of rural water-supply and his colleagues in the Executive Council and his Secretaries are helping him sincerely in this noble work. If His Excellency's Government succeed in removing this wide-spread water-difficulty in Bengal, it will earn the blessings of God and the gratitude of the entire Bengali nation. The Hon'ble Mr. H. L. Stephenson, Financial Secretary, Government of Bengal, has been specially selected to grapple with the water-supply question, and an abler and a better selection could not have been made. His Excellency Lord Carmichael has given out that he will take up the subject of rural drainage next year.

Where is the money to come from?

Of course it requires a large amount of money to carry out the remedial measures noted above. The question then is—Where is the money to come from? Now there are at least two local rates which should be applied to such a purpose. One is the road cess which was levied, 40 years ago, solely for the improvement of rural tracts in Bengal. If the Road Cess Fund had been allowed to do its legitimate duties from the very beginning, instead of being diverted to illegitimate purposes, our villages would have never been in their present deplorable condition. The cess has, however, been earmarked for the purpose of improving means of communication, drainage and water-supply, and we trust it will henceforth be applied to the purposes for which it was intended.

There is then the Public Works cess. It is in the possession of the Government of India, and only twenty-five per cent. of its proceeds are available for Bengal. But why should it not be wholly localised and made over to our District Boards? The Conference will confer a deep obligation on the people of Bengal by recommending the Supreme Government to do an act of bare justice by surrendering the entire Public Works cess to the Local Government. Over and above this, Imperial grants should also be made available for sanitary purposes. Considering that it is a question of life and death with the people of Bengal, we earnestly hope the Government of India will be pleased to contribute liberally to avert the terrible doom that awaits the Bengali nation.

Extirpation of Mosquitoes.

Now a few words on the extirpation of mosquitoes and the use of quinine. They are but palliative anti-malarial measures. Mosquitoes only carry and not create poison. So supposing we succeed in exterminating them, other insects, visible or invisible, not yet discovered, may carry and inject it into the human system. And then, is it possible to slaughter the race of mosquitoes when we cannot use guns, swords and lathis against them and when a drop of dirty water brings myriads of them into existence? It may be possible for people in Italy and elsewhere to protect themselves from the bites of mosquitoes by various costly means, but this is an utter impossibility in Bengal which is flat and alluvial, where rainfall is excessive, and the mass of the people extremely poor.

All the same there is no doubt that we may be free from one of the potent agents of disseminating malaria if we can extirpate the species of anopheles. But, why should we resort to "mosquito brigade" when good drainage and pure water are perhaps the two most effective means of extinguishing them? From this point of view, not only shall we be able to get rid of the breeding grounds of malaria and its carriers but expel the disease itself root and branch if the marshy tracts of the country were drained and stocked with pure in the place of dirty water, and our damp villages made dry. Ague was driven from England not by killing mosquitoes but by draining its marshy parts.

Quinine.

As for quinine, there is no doubt that we cannot do without it in malarial and other kinds of fever; but it has its disadvantages too. Indeed, the constitution oftentimes is utterly shattered by quininising it excessively. In my humble opinion, therefore, instead of asking the people to use it indiscriminately as is done now, they should be warned against its injurious effects and advised to make a judicious use of it, under medical advice, where available.

Rat and mosquito theory.

I shall end my paper with a little story. It is a reflection against the rat and mosquito theory; all the same it conveys a good moral. For myself, I am not a Jain, nor have I attained to that passionless state when people forego the pleasure of giving a slap to the mosquito when it sucks their blood, or knocking down the rat when it carries plague poison before them. But to the story.

The subjects of a certain king were very much troubled by snakes. The mortality from the bites of these reptiles grew so heavy that a royal proclamation had to be issued for the extermination of the serpent race. In due course all snakes in the kingdom were killed. The next year it was observed that the harvest was not such a bumper one as before; it was still less in the following year. Gradually the peasants failed to raise any crop at all and there was famine in the land.

A commission of enquiry was appointed and it transpired that the destruction of snakes was the cause of the famine. The snakes used to destroy a kind of frog which ate up wheat and rice seedlings. These frogs, since the disappearance of their enemies, had multiplied very fast and made it impossible for the peasants to protect the crops from their invasion. The king was at last obliged to import snakes from a neighbouring kingdom and nourish them in order to save his country from further famines.

For aught we know to the contrary, the much-maligned rats and mosquitoes may have their good uses. Because we are ignorant of the purpose for which they have been created, we are not therefore justified in annihilating them, because certain species belonging to them are believed to carry plague and malaria poison. Indeed, who knows that in order to remove one evil by destroying them, we may not bring another in its stead? It should be borne in mind that, God being All-wise, it is not likely he has created anything without a purpose. The Simla Municipality some time ago issued an order to kill all neighbouring foxes. The Calcutta Municipality, many years ago, also issued a similar order in regard to the adjutant cranes, which infested the city. Yet it is a well-known fact that foxes and adjutants serve as good scavengers without charging a pice for their work.

ALL-INDIA SANITARY CONFERENCE, MADRAS, NOVEMBER, 1912.

VILLAGE SANITATION.

Conditions of villages.—In India all villages, especially those in densely populated districts, as in the case in Bihar, are, as a rule, in an insanitary condition. This state of things is due partly to the habits of the people, and partly to their ignorance of the rudimentary principles of hygiene. No care is taken to select a suitable site for building houses for residence or for making sheds for cattle. Dwelling houses have openings in one direction only and in the opposite direction there are crevices high up in the walls. The houses are ill-ventilated and they do not receive sufficient sunlight and fresh air. In the villages, houses are very closely situated with the result that air and sunlight are obstructed, and consequently tubercular diseases are increasing. Cattle are kept either in the front of dwelling houses or in the courtyards. Cow-dungs are accumulated in front of the house before they are taken to the fields for the purposes of manure. In the villages, which have more than one well, no particular well is reserved for the supply of water for drinking and culinary purposes. In wells there is indiscriminate dipping of all sorts of water pots, and the same wells are used for bathing and washing soiled clothings. Wells have no parapets. Ponds and tanks which are not sources of drinking water supply become breeding places for mosquitoes and give rise to malarial infection to the villagers with the result that the poorer inhabitants suffer from enlargements of liver and spleen. The ponds ought to be filled up by the people who should be aided for the purposes by local bodies.

Personal cleanliness.—There is not much want of personal cleanliness on the part of the people. Bathing in a river or at a well is common, and drinking and cooking utensils are rinsed daily. Clothes and beddings are often kept in the sun. But the people, due to their ignorance, are in the habit of bathing and washing their clothes in dirty tanks. The consequences of these insanitary habits are that they suffer badly during outbreaks of cholera, plague and malaria. These diseases may be prevented to a large extent.

Cholera.—This might be prevented by reserving a certain well in every village for every community for drinking and culinary purposes only. These wells ought to be protected by a wooden cover at a nominal cost. During the outbreaks of cholera, headmen of villages should arrange to cleanse out these wells at a small cost of four or eight annas, and get them disinfected by lime where permanganate of potassium is not available. The cost may be defrayed by the villagers themselves by a contribution of a half or one anna per head, the indigent being exempted from such contribution. The headmen should also explain to the villagers that such wells should not be used for the purposes of bathing or washing clothes.

Malaria.—Effluvia and miasma arising from putrid substances, drains and stagnant tanks in the interior of villages are the chief causes of the outbreak of malaria in the rural areas. The construction of works of public utility such as railways and roads also tends to contribute, to a certain extent, to the spread of malaria, by allowing water to accumulate in the side pits without providing for a drainage. Public works should be constructed with due regard to drainage from a sanitary point of view.

Quinine.—Quinine tablets, supplied by Government from the Alipore Juvenile Jail, ought to be supplied to village headmen also for free distribution to the poorer villagers, and the sale of quinine through the agency of village postmasters and school masters should be further popularised. The village postman should be entrusted with the sale of quinine on market days, and village Chaukidars may also be supplied with quinine for sale within their circle.

Small-pox.—The mortality from this disease is decreasing by the introduction of the system of vaccination. The benefits of re-vaccination after 5 years are not yet understood by the people. This ought to be encouraged.

Prophylaxis and enforcement of sanitary rules.—The people have not yet learnt that prevention is better than cure. The observance of sanitary rules must emanate from the wisdom of the people themselves, aided by expert knowledge, and must be desired of the people to be attained. No amount of sanitary rules and regulations can be of use to the villagers until they try to help themselves by their own willingness to avail themselves of the sanitary advice offered to them.

Plague.—The people have understood the benefits of evacuation, but they do not realise the evil consequences of throwing dead rats outside their houses. They should be impressed with the necessity of burning all the dead rats by cow-dung cakes. The village headmen, in co-operation with the villagers, ought to see that this is done as far as possible.

SAIYID ZAHIRUDDIN,

Delegate, Behar & Orissa.

ALL-INDIA SANITARY CONFERENCE, MADRAS, NOVEMBER, 1912.

Hygiene is not a modern science. It was known to the ancients. The laws of Manu relating to religious observances and performance of obsequies form a Sanitary Code. The Muhammadan jurisprudence has a book on purification based on hygienic principles. But all the ordinances are confined to personal cleanliness or domestic hygiene and they are well understood and strictly observed. The people do not require any enlightenment on the subject of personal hygiene. It is to be regretted, however, that the people lack badly in the knowledge of public hygiene. They do not know and they have not been taught that by violation of hygienic rules their own health is affected and that they are doing wrong to the community at large and to every individual member thereof, and that they can save themselves from the ravages of plague, malaria and cholera, if they only took the precautionary measures which cost little or nothing and that they will be aided by the State if they be willing to avail themselves of the sanitary advice offered to them; and that the remedy lies in their own hands. They are ignorant of the fact that they owe a duty to the community and to themselves. They do not know that by committing nuisances on places of public resort, throwing rubbish in front of their own houses, polluting rivers and wells they commit a wrong against the public and themselves and invite epidemics. They abstain from such acts not for their own advantage but for fear of prosecution.

We have assembled here to devise ways and means for educating the people in hygiene, the knowledge of which cannot be imported by legislation or compulsion, and also for furthering the measures for preventing the spread of epidemics.

GENERAL SUGGESTIONS.

1. A public health or sanitation Act may be passed by the Imperial Legislature.

2. Provinces which have no Village Sanitation Act should have such an Act.

3. The Provincial Sanitary Board should consist of experts and of non-officials interested in sanitation.

4. The Sanitary Boards should advise District Boards on matters relating to sanitation of rural areas, and have control over Sanitary Inspectors wherever appointed.

5. Hygiene should be introduced into all classes of schools, primary, middle and English.

6. In the award of scholarships preference should be given to those who pass in hygiene with credit.

7. The compilation, for distribution in rural areas, as an official publication, of Sanitary Primers in the vernaculars, giving elementary rules of hygiene and instructions for selection of site and construction of houses in villages.

8. The compilation of Sanitary pamphlets in the vernaculars should be encouraged.

9. In every District there should be a Sanitation Committee for urban and rural areas.

10. Sanitary Conferences should be annually held in every Province.

11. A Health Exhibition may be held at Divisional or District Headquarters in connection with Agricultural Shows.

12. A special Act may be passed for preventing the pollution of rivers, on the lines of the Rivers Pollution Prevention Act in England.

13. Compilation of Plague Primers giving the benefits of inoculation and rat destruction as the results of recent discoveries.

14. The issue of instructions to Sanitary Inspectors through District Sanitary Committees.

15. The compilation in the vernaculars of Sanitary Readers for girls, giving elementary and practical rules of domestic hygiene, with special reference to the care and nursing of children and first aids.

16. The award of special female scholarships to girls for hygiene.

BANKIPORE,
Dated the 12th November 1912

SAIYID ZAHIRUDDIN,
Delegate, Behar & Orissa.

PART XI.

ADULTERATION OF FOOD AND DRUGS.

476DE

Inspection of food and Drugs in relation to Public Health.

I INTENDED to write a paper on the inspection of food and drugs in relation to public health. But on closer investigation I found that nothing has been done in the way of inspection of drugs, not only in Madras but in the other big cities in India also. In fact nothing is practicable under existing conditions. I think that the enactment of a Pharmacy Act for India taking into consideration all the peculiar circumstances of the drug trade in this country is the only way to meet the difficulties which we at present are confronted with in enforcing purity of drugs in the interest of public health. I shall, therefore, exclude the consideration of inspection of drugs from the scope of this paper and confine myself to the question of inspection of foods.

As my experience is confined mainly to Madras, I have based my observations on facts gathered in this city. But I understand that the experiences of observers in Calcutta and Bombay so far as adulteration of foods are concerned are practically the same as those of sanitary workers in Madras.

The deaths from bowel complaints form a very appreciable proportion of deaths from all causes within the city of Madras as the following figures will illustrate:—

Year.	Total number of deaths from all causes	Deaths from bowel complaints.
1904-05	19.305	3,235
1905-06	30,060	6,913
1906-07	23,749	5,704
1907-08	20,638	4,466
1908-09	22,285	4,225
1909-10	19,354	3,701
1910-11	20,312	3,635
1911-12	21,771	4,854

As a large percentage of deaths from bowel complaints are directly traceable to impure and adulterated food, the question of a proper control over the sale of food stuffs is of the utmost importance to this city. Till the year 1909 practically nothing was done here in the way of inspection of foods. But since April 1909, and especially since the advent of the present Health Officer, the Health Department of the Madras Corporation has been fairly active in inspecting foods and destroying unsound and decomposed food materials and prosecuting the vendors of such damaged or adulterated articles.

The chief articles of food with which we have to deal here are—

Rice.—Rice forms the staple food of a very large proportion of the population of the city. There are three kinds of rice used in Madras now, *viz.*, raw rice or table rice, boiled rice and broken rice.

Raw rice or table rice is generally used by Brahmans and Europeans. Raw rice is imported into Madras from the northern districts chiefly from Nellore, from Rangoon and from Bengal to a limited extent. Nellore rice is termed to be superior rice and is used by the wealthy and middle classes. It is often adulterated with inferior rice obtained from other places and sold as superior Nellore rice.

Boiled rice is mostly used by the non-Brahman community and is said to be easily digestible. It is obtained generally from Bengal, Rangoon and the villages surrounding Madras. It is also manufactured in Madras to a large extent, especially in the Tondiarpet division of this city. The manufacturers purchase paddy in the outlying districts, bring it into Madras and convert it into boiled rice. The paddy is soaked in water for three or four days, then boiled, then dried and lastly pounded. The different varieties in boiled rice is due to the different kinds of paddy used and also to the mode of manufacture. Well water is mostly used for soaking and boiling the paddy. Large earthen troughs firmly fixed in the ground are used for soaking it and large earthen pots for boiling it. Old paddy is generally soaked in water for three days and new paddy for four days. Often they are kept in the water for a longer period. The reason for this is that the grains bulge out enormously and in measuring occupy more space than they would otherwise do This is advantageous to the manufacturer in the long run. Also the same water is used for a number of days for different shifts of paddy, with the result that the water produces an offensive smell which is imbibed by the rice. That is why inferior boiled rice always gives out a sort of undesirable smell.

Broken rice is imported from Rangoon. Rangoon whole or broken rice is generally used for manufacturing cakes of various sorts and also as food by the inferior classes, especially when boiled rice is dear.

Previous to 1909 deteriorated and mouldy broken rice was imported into Madras in large quantities. The regular destruction of unsound foods discovered in the Port Trust premises and the frequent inspection of rice godowns in North Beach Road seem to have had a deterrent effect both on the consignees and consignors. It is also said that much of the broken rice from Rangoon finds its way to Colombo for the manufacture of a kind of liquor. But fortunately broken rice is not now imported into Madras in large quantities and deteriorated broken rice is rarely to be seen in the Port.

Wheat.—Next to rice, wheat is the article of food most extensively used in Madras. Wheat as grain is imported into Madras only in limited quantities, and the food inspector has not come across any damaged or deteriorated wheat in the bazaars in the city. Wheat flour is obtained in large quantities from Bombay and Bengal. Australia was the chief source of supply hitherto, but recently Bombay has taken her place. The flour now sold in bazaars in packets with labels containing the words 'Good Australian Flour' is not really Australian flour but Bombay flour. Three kinds of flour are obtained from Bombay—export, household and superfine. Superfine stands first in quality, household comes next and export is the last. The difference in the qualities of these kinds of flour is due to the varieties of the wheat from which they are obtained.

Yellow flour obtained from yellow wheat is not imported into Madras, though it is termed superior in quality and therefore mostly used in Bombay, as it is likely to be mistaken here for old flour which is also yellow in colour.

The chief adulterants of flour are rice and millets, especially cholam. I am told that Bengal flour is adulterated with cholam, the presence of which is discovered by the round granules in the flour, which when put in the mouth, being brittle, readily yields to the teeth and melts away. Flour does not keep for a long time Yellow, gritty and sour flour, too old for use, is often seen in bazaars, but its condemnation as unfit for human food is not possible until the establishment of our laboratory. Water damaged flour has often been found in the Port Trust premises and destroyed.

The coarse flour called sooji is very dear and so used only by the higher classes. The fine powder called flour is used by all and chiefly by bakers for manufacturing bread, biscuits, buns, etc.

Bread.—To secure good bread there should be good flour and good yeast. Often bread whichis dark and heavy, closer in texture and imperfectly vesiculated is seen in inferior bakeries and bazaars. This shows that adulterated flour is used for manufacturing bread. Old yellow flour is also used for making bread and alum is added to check fermentation and to whiten the bread made of such flour.

Yeast.—Hitherto toddy was used. But now, as it is very dear, being sold at five annas per measure, it is replaced by yeast prepared from potatoes and hop flowers. The potatoes are boiled, their skins pealed off and then squeezed into a mass. This mass together with hop flowers is again boiled. A definite quantity of flour is added to the decoction thus got and the whole mixture is allowed to stand till evening. Then it is added to the flour which is to be made into bread. Yeast powder or baking powder is not used. Malt is used in the Government bakery. In some bakeries toddy is used for making biscuits.

Bake-houses.—Now a few words about the places where bread and biscuits are manufactured. There are sixty-two bakeries in Madras at present. Half of them are in a good condition and the rest are yet in an unsatisfactory condition.

To prevent the spread of contagious diseases through the workmen of the bakeries, a new condition was introduced last year by which all workmen in the bakeries should obtain medical certificates as to health. Certificates, however, are not obtained for all the workmen in some of the bakeries, especially in those of the third class. In these places there are always a set of men under the pay and control of the proprietor or keeper of the bakery, who bake his bread, while there are other men who hire the oven of the bakery during certain hours. The latter for the most part knead the flour and prepare everything in their own places, which are not under the control of the Corporation. The men under the control of the proprietor have medical certificates, while the others have none. The latter have no aprons and if they are at work when an inspecting officer visits the bakery, they at once borrow the aprons of the workmen of the proprietor, in cases where the proprietor has provided aprons for his workmen. Unless the hiring system is abolished, matters will not improve.

The other cereals besides rice and wheat are not used in Madras to any appreciable extent and so nothing need be mentioned about them here.

Pulses.—The chief of them which are used in Madras are—

Bengal gram, red gram, green gram, black gram and peas. All these are imported into Madras in large quantities from Bengal. They are also obtained from some of the districts of the presidency They are for the most part good, though sometimes injured by insects or mixed with an unnecessary amount of dust and dirt. It takes a long time for them to deteriorate. Red gram is generally soaked in water for one or two days and then dried before being converted into dhol. It is often dried in very objectionable places—in streets on bare ground, next to dust bins, sewer syphons, etc. Often the same water is used for a number of days for soaking the gram.

Ghee.—Ghee is made by heating butter till a clear and sweet smelling residue is left. Cow's and goat's ghee is slightly yellow in colour and fluid in hot weather and semi-solid in cold weather. Buffalo's ghee is white and semi-solid in hot weather and solid in cold weather.

The production of ghee in any country depends upon the number, health and milk-yielding capacity of the milch cattle the country has. The more these conditions are favourable, the more milk and consequently the more ghee is produced. Until seven or eight years ago, the ghee producing districts of the presidency had a very good number of healthy milch cattle and so there was an abundant supply of ghee from these places. Rinderpest and other cattle diseases and the frequent recurring famine played havoc among the cattle of the presidency during recent years, and the result is the deficiency in the supply of ghee and the consequent rise in its price. The market price of ghee eight years ago was Re. 1 or Rs. 1-2-0 a viss and at no time did it rise higher than Rs. 1-8-0 a viss. Now the market price of pure ghee ranges from Rs. 2 to Rs. 2-4-0 and the price of the worst form of ghee is Rs. 1-8-0 which is exactly equal to the highest price of pure ghee seven or eight years ago. In order to keep up to the altered condition of the times, to make the supply equal to the demand and at the same time to get as much profit from the concern as possible, the merchants have resorted to adulteration. Adulteration has become almost universal and at present I doubt whether there is even a single shop in the whole city in which pure ghee can be obtained. The so-called pure ghee is only an adulterated ghee,

differing in the degree of adulteration from the other kinds of ghee in the same shop. The price of ghee bears an inverse proportion to the degree of adulteration.

There are nearly 380 ghee shops in Madras (wholesale and retail included). The ghee sold in these shops is obtained from one or other of the following places :—

Cuddapah	
Proddatur	
Jammalmadugu	
Muddanur	
Tadpatri	
Kamalapuram	Cuddapah district.
Vontimitta	
Nandalur	
Rajampet	
Madanapalli	
Nellore	
Kandukur	Nellore district.
Ongole	
Sulurpet	
Banganapalli	
Kambam	Kurnool district.
Nandyal	
Dharapuram	
Katpalli	Bangalore.
Indupuram	
Adoni	Bellary district.
Bellary	
Tiruvallur	
Sadras (Chadarangapatam)	Chingleput district.
Chembarambakam	
Salem.	
Guntur.	
Vellore.	
Chittoor.	
Nagalapuram.	
Nagari.	
Rajahmundry.	
Bombay.	

But the chief sources are the places mentioned under Cuddapah district and Salem.

Ghee is imported into Madras mostly in an adulterated form, but adulteration takes place in the city also, to some extent. The latter is of the worst form and its price ranges from annas 12 to Rs. 1-4-0 per viss. This is sold generally in petty bazaars in and around markets and also in some retail bazaars where two or three kinds of ghee are kept for sale. In both the places this form of ghee is intended for the consumption of the lower classes, and so it is not shown to others. Sometimes butlers purchase this ghee and thus cheat their European masters who are made to pay the price for pure ghee. There is also a large gang of hawkers in the city who deal in this form of ghee. They invariably carry the adulterated ghee in earthen pots on their heads and at the same time take also small quantities of good ghee in tin cans in their hands to be shown as samples of the ghee they have and thus cheat the people. They generally appear in the streets from about 10 a.m. to 3 p.m. when the male members are absent from their houses.

The chief centres of local adulteration are Chintadripet, Periamet, Pudupet, portions of sixth, seventeenth and eighteenth divisions. The chief adulterants employed in the city are animal fat, ground-nut or kusumba oil, plantains and potatoes. There are two methods of manufacture, *viz* :—

(1) Animal fat and oil are mixed together in a tin and boiled. Then a little quantity of good ghee is added to the mixture. For every four visses of oil, one viss of

good ghee is added, if the fat is in a solid condition, and one and a half visses of good ghee if the fat is in a semi-solid condition.

(2) Plantains and potatoes are well boiled and kneaded after they are pealed. Then this mass, fat and oil are mixed together in a tin and boiled. And finally a small quantity of good ghee is added. This preparation would keep for fifteen or twenty days.

Sources of animal fat in the city.—Animal fat is obtained by the local manufacturers either from the skin merchants or from butchers. The skin merchants get large quantities of fat in kerosine tins from the mufassal. Some of the butchers who slaughter cattle in the slaughter-house take fat home and sell it to their customers including ghee manufacturers, while others sell their animal fat in the Moore Market. The major portion of the fat sold in the Moore Market is purchased by the manufacturer of Oriental Balm, a little quantity is purchased by butlers and the rest goes through the pariahs in Cox Street to the ghee manufacturers. Sheep fat is generally sold at As. 5 per lb. and bullock or buffalo fat at As. 4 per lb.

The adulterants used in the mufassal are fat, plantains, kusumba or groundnut oil, castor oil or castor oil seeds and ashes.

Mode of manufacture in the mufassal according to information obtained in Cuddapah.—Animal fat, ghee and oil are first mixed in a tin and then heated till the ghee and fat melt. Then the tin is removed from the oven and placed over a small sand mound soaked in water. By thus suddenly cooling the mixture, all the articles combine well and solidify. Finally betel leaves soaked in butter milk for two or three hours are put into it, in order to give it a sweet smell. If plantains are used, they are boiled, the skins are pealed off and the pulp is made into a mass The mass is put with the mixture before heating. Ashes are added to increase the weight. In the districts north of Nellore, castor oil seeds are said to be ground together and added to ghee.

Sources of animal fat in mufassal.—The chucklers living in and around the villages and towns in Cuddapah district slaughter cattle, especially buffaloes, and sell the fat to the merchants. The chuckler looks upon this as a lucrative profession, inasmuch as by selling the fat, hide, etc., of the animal slaughtered, he realizes more than what he paid for the animal. Suppose he purchased the animal for Rs. 40, he realizes more than Rs. 50 by the sale of the fat, hide, etc., of the animal. So people are ever ready to slaughter animals and to supply the merchants with fat. It is said that nearly three tins of fat can be obtained from a buffalo. The fat thus obtained from the chucklers from time to time is stored by the merchants in their shops along with ghee tins. The Corporation Food Inspector reports having seen tins of pure animal fat in many of the shops in Proddattur, Muddanur, Kamalapuram and Tadpatri. In all places where ghee is manufactured in Cuddapah district there are also butchers' shops or skin godowns wherefrom the merchants can get fat whenever needed.

Always two kinds of ghee are obtained from Cuddapah district, one of which is semi-solid and the other solid. In the tins containing the ghee of the first kind, the topmost portion is in a liquid condition, the rest in a solid condition. The liquid ghee is the kusumba oil and the rest is a mixture of fat and ghee. So in every shop as soon as we ask the shop-keeper to show us the ghee. he puts a ladle into the tin, stirs the contents well, takes out the solid ghee from the bottom and shows it to us. The second kind of ghee is nothing but a mixture of animal fat and ghee. The first is dearer than the second as it contains less animal fat and more ghee. The first is sold at Rs. 12 or Rs. 12-8-0 per maund and the second at Rs. 10-8-0 or Rs. 11 a maund.

Sweetmeat bazaar and coffee hotel-keepers in the city use the second kind of ghee. They mix the flour with the ghee and boil in kusumba oil. Foods which are to be soaked in curd and all other stuffs which are to be sold in a day are prepared in kusumba oil. Kusumba oil has neither taste nor smell, and so it cannot infuse into the articles prepared in it any perceptible qualities of its own. This is taken advantage of by the ghee sellers and sweetmeat manufacturers. The ghee seller says that the ghee mixed with kusumba oil is pure cow's ghee, inasmuch as cow's ghee always assumes a liquid form. The sweet-meat seller asserts that the foods prepared in kusumba oil were prepared in pure ghee. In both the cases the purchasers are led to believe their statements under the above

circumstances. The evils attributed to the foods manufactured in sweetmeat bazaars and coffee hotels are due more to the adulterated ghee and kusumba oil than to the other articles which go to form the foods.

Vegetable Oils.—The most important oils used in Madras are gingelly oil, coco-nut oil, ground-nut oil and kusumba oil. Kusumba oil forms the chief adulterant of other oils, and it is difficult to get the other oils in a pure state without an admixture of kusumba oil. Kusumba oil is chiefly obtained from Cuddapah district, where it is sold at Rs. 4 or Rs. 4-8-0 per maund.

Butter.—Formerly there were no dairies at all in Madras, but within the last four or five years many have sprung up and there are now fifteen dairies in Madras. Many of the dairymen have their own cattle. Some keep the cattle within the city limits, while others outside the town in the surrounding villages, wherefrom they get milk everyday. Some of the dairymen have no cattle and they purchase milk locally as well as from the surrounding villages. The major portion of the buffalo's milk in the city goes to them, and hence the dearness of buffalo's milk. Cow's milk is sold from four to six annas a measure and buffalo's milk from six to eight annas a measure The dairymen also send their servants with vessels every morning and evening to the neighbouring villages, who go from door to door and purchase as much milk as they can get in each house. They also advance money to the sellers of milk in the villages.

The skimmed or separated milk is sold by dairymen to Kannadairs (curd sellers), coffee hotel-keepers and hawkers. Kannadairs enter into regular contracts with the dairymen for the purchase of milk and deposit certain sums of money as security for the due fulfilment of their contracts. Skimmed or separated milk is sold at six to eight measures per rupee during hot season and ten to twelve measures during colder weather.

Adulterants of butter are water, curd, foreign fat, rice flour, and tinned or preserved butter. Butter sold in dairies is generally adulterated with water and tinned or preserved butter. They put the butter in a vessel containing water and go on striking it gently until it absorbs as much water as it could contain without detection. Thus one pound of butter is made into three pounds of butter. Tinned butter is obtained largely from Bombay from the following Companies:—

The Crown Dairy Company,
Champion Dairy Company,
Alfred Dairy Company,
Scottish Dairy Farm, and
another Company having Tram Car Trade Mark;

and preserved butter in the form of cakes from England and other places.

Some dairymen themselves have admitted that the butter from the above Companies is not pure, but is adulterated with animal fat. Then two or three tins of the above kind and a pound of pure local butter were purchased; both were clarified and compared by the Health Officer. The tinned butter did not yield as much quantity of ghee as the local butter. Secondly the ghee got from the tinned butter smelt something of lard. Then samples of tinned butter were sent to the Chemical Examiner, Madras, for analysis, who declared that it contained nothing but butter fat and boric acid added to preserve the butter. It may be that the tinned butter as a whole is pure or the particular tins sent for analysis contained pure butter. Further investigation is required before a definite conclusion can be arrived at.

Butter sold by curd sellers is generally adulterated with curd or flour. They take solid curd, put it in a cloth and suspend it. Whatever water the curd may contain flows out until at last only a solid mass is left behind in the cloth. This mass is mixed with butter. That is why some of the Hindu females who know the trick of the trade, first put the butter in a vessel full of water. After stirring it for a while, the foreign ingredients such as flour, etc., sink to the bottom and pure butter floats on the surface of the water. Then they take out the butter from the vessel and remove the extra water which might have got into the butter during the above process, by putting the butter in a clean cloth and twisting it loosely. Thus they are able to purchase pure butter.

The chief preservatives added to butter are salt and boric acid. Salt is removed from the butter, by washing it several times before sale. Butter is coloured with annatto to make it appear as cow's butter.

Milk.—Milk is obtained locally as well as from the neighbouring villages. The local dealers adulterate milk with pipe water and the villagers with tank water, well water or any other kind of water they may find on their way. The hawkers who purchase skimmed or separated milk from the dairies add to it buffalo's milk so as to bring it to its usual form before sale. Some coffee hotel-keepers, I hear, add kanji water to skimmed milk in order to thicken it. There are some people who sell milk during nights at junctions of important streets. These, I am told, dilute the milk with a large quantity of water and add rice flour and a little sugar to it. This milk is always kept a little hot.

Tinned food.—As these foods are manufactured and packed in tins by machine, there is no room for pollution and so will keep for a fairly long time. But if kept too long, they become rotten and unfit for human consumption.

Tinned foods, which were very old, were being sold in the city in public auction along with other wares. Sometimes the articles sold happened to be either unwholesome or unfit for human food, and they passed into the hands of the consumers without the auctioneers and even the vendors knowing them to be in such a state. This was discovered and measures were taken to put an end to the practice.

All the auctioneers in the city were informed, through a circular from the Health department of the dangers arising from the sale of old and rotten tinned foods and were asked to send on all future occasions on which they are to sell articles of human food, lists of such articles to the Health Officer a few days before the auction, to enable him to examine them and see if they are fit for human consumption.

There is a large gang of hawkers in the city who deal in these old and unwholesome tinned foods. They generally purchase these foods in the larger firms and sell them in the streets. Attempts are being made to break up this gang. One of the hawkers was found selling some tins of damaged condensed milk in China Bazaar Road on February 20, 1912. The tins were seized and destroyed with the consent of the owner under Section 355. To set an example to the gang of hawkers, he was prosecuted under By-law 169 and was fined Rs 7 on March 15, 1912. As he admitted before the Magistrate that he had no property whereupon the fine could be levied, he was sentenced to seven days' simple imprisonment under Section 454 (2).

While on the subject of tinned foods, a few observations on condensed milk sold in the city may not be out of place. There are several brands of condensed milk, many of which have been prepared from skimmed or separated milk, as can be seen from the labels on the tins. It is a well-known fact that much of the condensed milk is used as food for children. It is also an established fact that condensed milk prepared from skimmed or separated milk, which is very poor in fats, is injurious to the health of children. That is why in some of the colonies such as Hongkong, South Africa, Jamaica, Trinidad, Cuba, Costa Rica, and in Colombo special ordinances were made to prevent children from consuming such milk. As an example I shall quote below the ordinance in force in Hongkong on this subject.

' Every tin or other receptacle containing condensed separated or skimmed milk sold or exposed for sale for consumption in the colony shall bear a label ; and on every such label and on the wrapper, if any, of every such tins or other receptacle, there shall be printed in large and legible type in English and Chinese the words ' this is skimmed milk. Children under one year of age should not be fed on it,' and if any person sells or exposes or offers for sale for consumption in the colony condensed separated or skimmed milk in contravention of this Section, he shall be liable on summary conviction to a penalty not exceeding 100 dollars and, in default of payment thereof, to imprisonment, with or without hard labour, for any term not exceeding three months.' This matter has also been taken up by the Government of Bengal (*vide Indian Trade Journal*, Calcutta, Vol. XXIII, No. 296, dated November 30, 1911).

Aerated Waters.—There are nineteen Aerated Water Factories in the city at present. Of these five are in possession of expensive filtering plant and under efficient European supervision. Of the remaining fourteen, two have improved and the rest are in an unsatisfactory state. These factories are in possession of sand filters. These were condemned by the Health Officer as absolutely useless, the men in charge being quite ignorant of the methods of working them, and an easier and safer method of purification of water was introduced.

Apart from the question of filtration, there is another dangerous system prevelant in these factories, which accounts for the sale of very impure waters containing flies, ants and other insects, and that is the system of hiring waters. The proprietors of the Aerated Water Factories besides manufacturing their own waters, hire waters to others at the rate of nine pies or one anna per dozen bottles. The latter class generally bring their own syrups, essences, etc., necessary for the manufacture of their coloured waters to the factory. They pay nine pies or one anna for every dozen bottles for charging them with carbonic acid gas They generally fill the bottles first with the ordinary unfiltered pipe water from the factory. As a rule they conduct their business in the factories at late hours in the evenings and during nights, when there is no fear of the factories being inspected by the Corporation officials. They seldom clean their bottles. As soon as they sell their waters, they go to the factories and charge the bottles at once with waters. The remnants of syrup which may remain in the bottles attracts flies and ants which appear in the bottles after they are again charged. These people invariably do not label their bottles. One of the conditions of the license prohibits the issue of any waters from an Aerated Water Factory without the trade label of the licensed manufacturer thereon. But this provision is found from experience to be not sufficient to check the hiring system.

Fruits.– Plantains keep for a longer time than oranges and other fruits. Sometimes oranges and other fruits arrive in Salt Cottaurs in large quantities from Bangalore and other parts. As soon as the waggons are opened, the rotten fruits are separated and sold on the spot to a great extent, failing which the whole consignment goes to the godowns in and around Kothawal Bazaar. The separation business does not take place in Salt Cottaurs with regard to the fruits which arrive in baskets. They are straightway taken to the above godowns. In these godowns all the rotten fruits are separated and auctioned. Petty dealers, especially vendors on the sides of streets and hawkers purchase them. Thus the rotten fruits are distributed throughout the city.

Coco-nuts.—The coasting boats and the South Indian Railway bring in most of the coco-nuts. As soon as a consignment arrives, the rotten ones are separated and sold. The oil mongers in the city purchase large quantities of these rotten coco-nuts in order to extract oil from them. They break the coco-nuts, dry the kernels and put them in the oil mill along with gingelly seeds. This is one way of adulterating gingelly oil with coco-nut oil.

Oysters.—Oysters are gathered in the following places :—

(1) Mouth of the Adyar River from the lock to the bar, especially at the bottom and surroundings of Adyar Bridge.

(2) Under the small bridge in South Beach Road to the south of Rifle Range and the eastern gate of the Admiralty House.

(3) Northern arm of the harbour and within the harbour to a limited extent.

(4) In Ennore in the lake between the southern lock and the bar, especially in and around the railway bridge.

(5) Covelong.

(6) Sadras.

(7) Pulicat.

Sources Nos. (1), (2), (3) and (4) are polluted by sewage. The danger becomes enhanced during rains. The remaining sources are free from contamination. Moore Market is the only place where oysters are sold in Madras, and sources (1) to (4) are its feeders. Many Europeans or their butlers go to Ennore, Covelong and Sadras, purchase oysters there in large quantities and either bring them home or eat them there.

The oyster beds in the lake around Pulicat are under the control of the Government Fisheries Department and oysters are gathered there only by that department.

Fish.—Fish caught in Rayapuram, Cassimode, Ennore and Pulicat find their way to the markets of the northern part of the city, while those caught in Mylapore, Adyar and Covelong go to the markets of the south range Fish from the former are first brought to Parcherry market, wherefrom they are dirtributed to the other markets. The bigger ones which may be left behind after distribution are packed in ice and sent to inland districts, especially Bangalore; the smaller ones are salted. Fish find a ready sale in the markets. Sometimes when the supply is too much, they are kept for more than a day, when they become rotten.

Of the food materials described above I shall take two for special mention, namely, rice and ghee. These are the two staple articles of diet among the people of this city. The supply of rice from Rangoon is fairly satisfactory except during the prevalence of the south-west monsoon. Most of the rice mills in Rangoon have not sufficient accommodation for warehousing the rice. They try to export the rice as rapidly as they produce it. If they are not able to do so they store the rice in bags in the open. This procedure answers well in the hot months. But when the monsoon bursts, the rice bags get wet, and heat in the hold of the steamer which conveys it to Madras makes the rice very mouldy. And it is a remarkable fact that the annual outbreak of cholera in Madras synchronizes with the arrival of the mouldy rice from Rangoon after the burst of the south-west monsoon. The south-west monsoon usually bursts about the end of May or beginning of June and it will be about the end of July or beginning of August before rice which has got wet in the monsoon rains in Rangoon finds its way into the Madras market. And the following table will show the dates of commencement of the cholera epidemic in Madras with the number of attacks and deaths in each year :—

Official Year.	Date of commencement of cholera epidemic.	No. of cases.	No. of deaths.
1905-06 ...	July 21, 1905	5,067	3,684
1906-07 ...	Last week of August ...	740	564
1907-08 ...	September 6, 1907 ...	918	691
1908-09 ...	August 7, 1908	1,244	902
1910-11 ...	Last week of July, 1910 ...	193	153

The figures I gave at the beginning of this paper of deaths from bowel complaints do not include deaths from cholera and they occur all through the year. But our cholera epidemics generally occur during the months of July, August and September and the arrival of the mouldy rice from Rangoon to a certain extent constitutes one of their etiological factors.

There is another very important factor in the production of these annual epidemics of cholera in Madras, which though not directly connected with our food materials, is of sufficient importance to be mentioned here. The water-supply to the city of Madras is from the Red Hills lake situated about nine miles' distance from here. The delivery channel for the water-supply has its intake at a fairly high level. And so when the level of the water falls below the intake of the delivery channel, the lake still has about fifteen feet of water in it and pumping has to be resorted to in order to get the water from the lake into the delivery channel. One result of pumping is to make the water more turbid by stirring it up and to increase the number of bacteria in the water. And with no filtration of the water it is not surprising that pumping at Red Hills has been found to coincide with the outbreaks of epidemics of cholera in Madras. But it must be admitted that there have been years during which there was no pumping at Red Hills and yet there were epidemics of cholera in Madras. Both the mouldy rice from Rangoon and the dirty water from the Red Hills contribute their own share towards the causation of cholera epidemics. The new water works when they are completed are expected to prevent the injurious influence of the present dirty water-supply. Fresh and stringent legislation empowering the public health authorities in Madras to deal effectively with impure food will be the only means of suppressing the other factor in the starting of cholera epidemics.

Appended to this paper are suggestions for amendments and additions to the existing sections of the Municipal Act dealing with inspection of food and drugs. In dealing with the importation of impure food into this city something further will also be required. The public health authorities ought to be empowered to board steamers or vessels which are bringing in impure food and to inspect them and if impure food is found on board to prevent its landing. At present the Local Government has power to make rules for the inspection of vessels containing impure food stuffs under the Indian Ports Act, 1908.

The next article of food to which I wish to draw special attention is ghee. One touch of adulterated ghee makes whole India kin, and the question of the prevention of adulteration of ghee is of equal importance to all provinces and cities of India. I have already explained the principal methods of adulteration of ghee practised in Madras. That, however, will hardly give a real idea of the sort of material called ghee which is exposed for sale in the shops in this city.

The following two cases reported by the Corporation Food Inspector with the report of the Chemical Examiner will give a fair idea of the extent to which adulterations of ghee is carried on here :—

(1) In the month of May, 1912, one Nambur Raghavulu Chetty, ghee-seller in No. 116, Anna Pillai Street, received five tins of ghee from one Perur Ramiah of Rajampet. When one of the tins was opened, the ghee was found to be in a bad condition giving out a rancid smell. So Raghavulu Chetty wrote to the consignor asking him to take back the ghee. The consignor refused and the subject is still under correspondence between them. Meantime the matter came to our notice and samples of ghee from the above tins were sent to the Chemical Examiner for analyses. The Chemical Examiner reported as follows :—

'I have the honour to give below the results of the analyses of the five samples of ghee received here on July 17, 1912, under unbroken seals which corresponded with the sample sent :—

—	Samples of ghee taken from ghee tins in Nambur Raghavulu Chetty's Shop in No. 116, Anna Pillai Street.				
	I	II	III	IV	V
Water per cent	19·4	47·0	23·1	trace	33·5
Vegetable matter ,,	38·8	11·4	30·4	...	18·0
Fatty matter by difference. ,,	41·8	41·6	46·5	nearly 100	48·5
	100·0	100·0	100·0	100·0	100·0

No. I had the appearance of vomited matter and an extremely foul odour. Nos. II and IV, particularly the latter, had an oily smell resembling that of ground-nut oil. No. III had a rancid oily smell and No. V somewhat resembled No. I but was not quite so foul.

The vegetable matter in the four samples I, II, III and V resembled pulped plantain and the objectionable smell of these samples is doubtless largely due to the decomposition of this vegetable matter in the presence of water.

With regard to the facts, samples I and V each contain a small proportion of butter fat mixed with a mixture of animal and vegetable fats. No butter fat could be detected in samples II, III and IV. They consist of mixtures of vegetable and animal fats.'

The above report reveals what kind of ghee is imported into the city. No one would like even to touch it. Still we were not able to do anything in the matter for want of provision in our Act. Nor was action possible under Sections 272 and 273 of the Indian Penal Code, as the ghee could not be declared to be noxious.

(2) In July, 1912, a Police Constable of the Egmore Police Station seized three tins of ghee from some of the professional adulterated ghee manufacturers in the city. He saw them mixing ghee and animal fat and filling the tins with the mixture. Just after the tins were sealed in a tinker's shop, they were seized by him. When he questioned the ghee manufacturers, at the time of seizure, as to the purpose for which the so-called ghee was manufactured, they told him that it

was intended to be sold in the city for human consumption. Subsequently they wrote to the Police that it was intended to be sent to a leather factory in Pallavaram.

As the Police were not able to take any action in the matter, they transferred the papers and the ghee tins to us for disposal. Then samples of the stuff contained in those tins were sent to the Chemical Examiner for analyses. He reported as follows :—

'I have the honour to state that the three samples of ghee received with your letter No. Ref. on H. D. 1449/Spl. of 1912, dated August 21, 1912, were examined and each was found to contain vegetable debris and starch of the same variety to the extent of nearly 2 per cent. The samples were of the same consistence as ghee; but no butter fat could be detected in any of them. They appear to be a mixture of animal and vegetable fats of practically the same composition. A distinct smell of castor oil is present in all of them.'

As in the previous case, we were not able to take action in this case also, either under our Act or under Sections 272 and 273 of the Indian Penal Code.

The question of fixing a standard of purity for ghee has often been raised, but only answered once and that was in the case of the Calcutta Corporation *v.* Satya Prya Koch and another. Dr. Dutt, the analyst to the Corporation of Calcutta, had in his laboratory prepared several samples of pure buffalo ghee and the one giving the lowest results he took for his standard for comparing with any given samples to be analysed. Both the magistrate who tried the case and the two judges of the High Court who heard the case in appeal accepted the standard arrived at by Dr. Dutt and convicted the accused. In my opinion the selling of adulterated ghee ought to be made a criminal offence, for in the words of Justice Prinsep and Justice Ghose, 'ghee is not such an article which an ordinary purchaser expects to be adulterated. The mode of its preparation, the purposes for which it is used precludes such a supposition.'

As to the improvement in the milk supply there are two directions along which vigilance has to be exercised. By fixing of standards for the purity of both cow's and buffalo's milk and enforcing the maintenance of those standards by the co-operation of the public analyst and the food inspector with the aid of the Criminal courts when necessary a good deal can be done in the way of ensuring a pure milk supply. And the other direction in which sanitary measures are to be undertaken is towards improving the cattle yards. In Madras, theoritically no cattle yards unlicensed by the municipal authorities have a right to exist; and no cattle yards which do not conform to the sanitary standards laid down by the Health department are supposed to be licensed. As a small preliminary both these theoritical suppositions ought to be translated into practical action. The necessary consequence of that will be that several cattle yards in this city will lose their licenses and several herds of cattle will be rendered homeless. To provide for such the Corporation ought to construct model cattle yards in each and every municipal division in the city, at convenient localities and compel the owners of cattle, who are unable to provide approved and licensed cattle yards for their cattle, to house their cattle in the Corporation yards on payment of a reasonable rent. These measures, if properly carried out, would, in my opinion, practically ensure a pure milk supply to this city.

And now I come to the practical steps to be taken to prevent food adulteration.

The present sections relating to food and drugs in the Madras Municipal Act are defective. They must be amended and considerably added to before they can be effectively utilized for the prevention of food adulteration.

I give below my suggestions for the amendment of the food and drug sections and the reasons for doing so.

APPENDIX.

Existing sections of the food and drugs chapter of the Madras City Municipal Act, 1904.	*Proposed amendments and additions.*
	Definitions. [The expression 'Food' shall include every article used for food or drink by man, other than drugs or water, and any article which ordinarily enters into or is used in the composition or preparation of human food; and shall also include flavouring matters and condiments.] [The term 'Drug' shall include medicine for internal or external use.] [The word 'Butter' shall mean the substance usually known as butter, made exclusively from milk or cream or both, with or

Definition of 'Food'.

If a flavouring matter, condiment or any other article of similar nature is found to be adulterated with a substance which is injurious to health and if the seller is prosecuted for the offence, it may be argued that such an article is not a food and the case may eventually fail. So the definition of food is necessary. Under section 2 of the Sale of Food and Drugs Act, 1875, 'Food' is defined as follows :—The term 'Food' shall include every article used for food or drink by man, other than drugs or water. Under this definition it was held that baking-powder consisting of 20 per cent of bicarbonate of soda, 40 per cent of ground rice, and 40 per cent of alum, the last being injurious to health, was not an article of food. It was also held that chewing gum containing 35 per cent of paraffin wax and gum mastic was not food under the above definition. Hence this definition was repealed by the Sale of Food and Drugs Act, 1899. Under section 26 of this act, the definition taken for our act is given.

Definition of 'butter'.

Definition of 'Butter' is necessary in order to show that it cannot be said to be adulterated by the addition of a colouring matter or preservative. Similar difficulties were experienced in the English courts before the introduction of such definition by the Margarine Act, 1887. For example, 'In Roose *vs.* Perry & Co. (1900), 44 S. J., 503, the defendant was sued in the County Court for damages for breach of warranty that certain butter supplied by him was "pure butter". An appeal was taken to Divisional Court on the ground that the Judge had erred in refusing to consider or decide what "pure butter" meant as an article of commerce, and in holding that, as a small quantity of boric acid had been added to it since it left the churn, it was not, in fact, "pure butter", and not therefore according to warranty. The court (Ridley and Bigham, J.J.) allowed the appeal.' Mr. Justice Bigham and: 'If the decision of the Judge was to be upheld in this case it seems to me that the mere introduction of a little salt would render the defendants liable. I cannot believe the parties ever intended that the butter to be supplied should be in the simple state that it left the churn, for the purchaser expected that some preservative would be added so that it should keep good while

without salt or other preservative, and with or without the addition of colouring matter.]

[The word 'Ghee' shall mean melted and clarified butter and shall contain nothing but fat exclusively derived from milk.]

[The word 'Margarine' shall mean all substances, whether compounds or otherwise, prepared in imitation of butter or ghee, and whether mixed with butter or ghee or not, and no such substance shall be lawfully sold, except under the name of margarine.]

[The expression 'Margarine-cheese' means any substance, whether compound or otherwise, which is prepared in imitation of cheese, and which contains fat not derived from milk.]

[The expression 'Cheese' shall mean the substance usually known as cheese, containing no fat derived otherwise than from milk.]

[The word 'Importer' shall include any person who, whether as owner, consignor, or consignee, agent, or broker, is in possession of, or in anywise entitled to the custody or control of the article.]

[The word 'Dealer' shall include a manufacturer, importer, consignor, consignee or commission agent.]

[The word 'Owner' shall include importer, consignor, consignee, shipping agent or broker.]

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exposed for sale in her shop. I should myself have had no hesitation in finding that this was pure butter within the meaning of the warranty, but that is a question of fact for the Judge and not us to decide. I think that he went wrong in refusing to take into consideration evidence that this expression "pure butter" had a meaning as used between the plaintiff and the defendants in trade apart from its natural meaning'.

The definition of 'Butter' suggested for adoption in our act is taken from section 3 of the Margarine Act, 1887.

Definitions of 'Ghee' and 'Margarine'.

The definitions of butter, ghee and margarine are introduced to distinguish butter and ghee from margarine, raw milk-fat being considered as butter, melted and clarified milk-fat as ghee, and the combinations of all other fats, whether containing milk-fat or not, and whether mixed with any foreign ingredients or not, as margarine. The definition of margarine suggested to be adopted in our act is taken from section 3 of the Margarine Act, 1887. No doubt section 13 of the Butter and Margarine Act, 1907, substitutes for this definition of margarine the following :—'any article of food, whether mixed with butter or not, which resembles butter, and is not milk-blended butter'. But for the purposes of our act, the former definition will do, with the addition of the words 'or ghee' after the word butter wherever it occurs in the definition.

Definitions of margaine-cheese and cheese.

The definitions of margarine-cheese and cheese are introduced to distinguish pure cheese from all imitations of cheese. The definitions are taken from section 25 of the Sale of Food and Drugs Act of 1899.

Definition of the words dealer, importer and owner.

The words dealer, importer and owner are defined to enable us to take action against any person who, whether as a manufacturer, consignor, consignee, agent or broker is in any way entitled to the custody or control of an article for the time being, while such article is being dealt with by us.

Section 352. (1) If the President has reason to believe that any animal intended for human food is being slaughtered, or that the flesh of any such animal is being sold or exposed for sale, in any place or manner not duly authorized under this act, he may, at any time by day or by night, without notice, enter such place for the purpose of satisfying himself as to whether any provision of this act or of any by-law or regulation made under this act at the time in force is being contravened thereat.

(2) No claim shall lie against any person for compensation for any damage necessarily caused by any such entry or by the use of any force necessary for effecting such entry.

Section 352. (1) If the President has reason to believe that any animal intended for human food is being slaughtered, or that the flesh of any such animal [or fish] is being sold or exposed [or kept] for sale, [or that any article of human food is being stored, packed, cleansed, or manufactured], in any place or manner not duly authorized under this act, he may, at any time by day or by night, without notice, enter any such place for the purpose of satisfying himself as to whether any provision of this act or of any by-law or regulation made under this act at the time in force is being contravened thereat.

(2) No claim shall lie against any person for conpensation for any damage necessarily caused by any such entry or by the use of any force necessary for effecting such entry.

Section 352 (1).

Under this section animals in the course of slaughtering and the flesh of animals on sale in any unauthorized place or manner may be inspected at any time without notice. This section is workable if the owner of any such place is willing to allow the inspection. But if he is not willing and consequently prevents the officer from entering the premises, there is nothing to make him liable to punishment for this offence.

It is also necessary to extend this power for the inspection of fish which are stored in many places in the city and which are sold stealthily while in a putrid condition. To quote an example—some time ago some rotten fish were found exposed for sale in parcherry market, seventh division. On inquiry the Sanitary Inspector of the Division was informed that they were purchased from a Muhammadan who had his godown in Angappa Naick Street. Then orders were issued to the Sanitary Inspector of that Division to inspect the godown and see if there were any putrid fish there. The Sanitary Inspector found the godown locked up, and he was informed that the owner was absent in Covelong. As there is no provision under which he could enter the premises by force or under which the owner could be prosecuted for preventing entry into the premises and inspection of the articles, he was not able to do anything in the matter except to post on the door of the house a notice under section 440, which gives power for general entry, but which is not penal.

In aërated water factories, bake-houses, and potato and onion godowns, business is conducted during nights also. So it is indispensable that these places should be inspected at times during nights.

There is a system of hiring waters in some of the aërated water factories, which accounts for the sale of very impure waters containing even flies, ants and other insects. The proprietors of these aërated water factories, besides manufacturing their own waters, hire waters to others at the rate of nine pies or one anna per dozen bottles. The latter class generally bring their own syrups, essences, etc., necessary for the manufacture of their coloured waters to the factory. They pay nine pies or one anna for every dozen bottles for charging them with carbonic acid gas. They generally fill the bottles first with the ordinary unfiltered pipe water from the factory. As a rule they conduct their business in the factories at late hours in the evenings and during nights, when, under the existing provisions of the act, there is no fear of the factories being inspected by the Corporation officials. They never clean their bottles. As soon as they sell their waters, they go to the factories and charge the bottles at once with waters. The remnants of syrup which may remain in the bottles attract flies and ants which appear in the bottles after they are again charged. To check this trade, it is necessary to make surprise inspections during nights.

New section. Fine to be fixed. Fine imposed under P.H.A., 1875 is £5. section 118.

(3) [No person shall in any manner prevent the President or any municipal officer deputed by him from entering any premises and inspecting any animal or any other article of human food exposed or deposited for the purpose of sale, or of preparation for sale.]

As regards bake-houses.—To prevent spread of contagious diseases through the workmen of the bakeries, it has been laid down as conditions of the license that all workmen in the bakeries should obtain medical certificates as to health, and that they should wear aprons while at work. Certificates, however, are not obtained for all the workmen in many of the bakeries of the third class. In these places there are always a set of men under the pay and control of the proprietor or keeper of the bakery, who bake his bread, while there are other men who hire the oven of the bakery during certain hours. The latter class, as a rule, have no medical certificates, nor do they wear aprons while at work. These people work in the bakery generally during nights. To put an end to this practice it is necessary to inspect the bake-houses during nights.

Regarding potato and onion godowns.—Potatoes and onions are brought into the city, not only for sale within the city, but also for export to other countries. Potatoes are generally sent to Calcutta in large quantities and onions to Rangoon, Penang, Singapore, and Straits Settlements. So large consignments of these articles almost always arrive in Madras. As soon as a consignment is received, it is unpacked, rotten portions are separated, and a part of the good portions is retained for sale within the city, while major portion is again packed and consigned to other countries. The necessity for separation in this place arises from the fact that, as it takes some days for the articles to reach their places of destination, the rotten portions if allowed to stand with the good would make the latter rot sooner than they would otherwise do. Sometimes the good portions of the potatoes are even washed and dried before being repacked. Some of the rotten portions are then given to the coolies engaged in the operation as wages for the work extracted from them, while the remaining portions are sold to a set of dealers in these rotten articles. These coolies and dealers in their turn sell them again to the poorer classes in various places in the city. Thus rotten potatoes and onions are spread for sale throughout the city. The danger from the sale and consumption of these articles is even greater in the rainy season. When there are rains in the Hills wherefrom potatoes are consigned to the city in large quantities and in the districts of the Presidency wherefrom onions are sent to Madras, the articles are generally packed while they are in a wet condition and so by the time they arrive here, major portions of them become rotten.

The business of separation, especially when the consignments arrive in a wet condition, and the sale of the rotten portions take place during nights. During the last three months, ten cart loads, twenty-four baskets and eight bags of rotten potatoes were found in these godowns and destroyed, the inspection of these places being made only during the ordinary working hours of the day. Had the godowns been inspected during nights in times of necessity much more would have been found and destroyed. Hence the necessity for the inspection of these places at any time without notice.

FIRST AMENDMENT.

Section 353. It shall be the duty of the President to make provision for the constant and vigilant inspection of animals, carcasses, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, milk, ghee, butter, oil and any other article exposed or hawked about for sale or deposited in or brought to any place for the purpose of sale or of preparation for sale and intended for human food, the proof that the same was not exposed or hawked about or deposited or brought for any such purpose or was not intended for human food resting with the party charged.	Section 353. It shall be the duty of the President to make provision for the constant and vigilant inspection of animals carcasses, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, milk, ghee, butter, oil and any other article exposed or hawked about for sale or deposited in or brought to any place for the purpose of sale or of preparation for sale and intended for human food [and to prescribe the kinds of utensils or vessels to be used for preparing, manufacturing or containing any such article and the state in which such vessels or utensils are to be kept], the proof that such article was not exposed or hawked about or deposited or brought for any such purpose or was not intended for human food [and that any such utensil or vessel is not of the kind or in the state not duly authorized under this section] resting with the party charged.
Section 354. (1) The President may, at all reasonable times, inspect and examine any such animal or article as aforesaid and any utensil or vessel used for preparing, manufacturing or containing any such article.	Section 354. (1) The President may, at all reasonable times, inspect and examine any such animal or article as aforesaid and any utensil or vessel used for preparing, manufacturing or containing any such article.

The difficulty in working section 354 lies in carrying away the articles seized. Under this section the following articles may be seized and carried away :—

(1) Articles which are diseased, unsound, unwholesome or unfit for human food.

(2) Adulterated articles or articles which are not what they are represented to be.

(3) Utensils or vessels which are of such kind or in such state as to render the articles prepared, manufactured or contained therein unwholesome or unfit for human food.

With regard to No. (1)—All articles seized cannot be carried away. Only portable articles or articles in small quantities can be removed from the place where they were seized by the Inspector or his peon. This difficulty was realized more than once in the case of rice bags found in an unsound condition in the import shed of the Port Trust premises and in some of the rice godowns in the North Beach Road.

To quote an example, 105 bags of broken rice were once found in an unsound condition in the Port Trust premises and the matter was reported to the Assistant Health Officer, South Range. Next morning the Assistant Health Officer on inspection condemned the article as unfit for human food. As it was impossible to carry away the bags, they were left in the shed, with clear written instructions to the delivery clerk of Messrs. Binny & Co., Ltd., in whose custody the bags were found, that they should not be removed from the premises until they heard further from the Assistant Health Officer. The consignee's gumastah also, who was present on the occasion, was likewise informed. This was done in the presence of the Assistant Health Officer. But what was the result? No sooner had the Assistant Health Officer and the Food Inspector left the spot, the bags were removed from the place and when the Food Inspector went to the shed again at 1 p.m. the same day, nothing was found there. The bags were removed in this instance within a period of three hours between 10 a.m. and 1 p.m. Then Messrs. Binny & Co., Ltd., the shipping agents,

(2) If any such animal appears to the President to be diseased, if any such article appears to him to be diseased, unsound, unwholesome or unfit for human food or to be adulterated or to be not what it is represented to be, or if any such utensil or vessel is of such kind or in such state as to render any article prepared, manufactured or contained therein unwholesome or unfit for human food, he may seize and carry away such animal, article, utensil or vessel, in order that the same may be dealt with as hereinafter provided.

(*Penal Section. Fine to be fixed.*)

(2) If any such animal appears to the President to be diseased [or if any such article, which is of such size or in such quantity as can be easily carried], appears to him to be diseased, unsound, unwholesome or unfit for human food, he may seize and carry away such animal or article in order that the same may be dealt with as hereinafter provided.

[If any such article, which is of such sizs or in such quantity as cannot be carried easily, appears to him to be diseased, unsound, unwholesome, or unfit for human food, or if any such article appears to him to be adulterated or to be not what it is represented to be, he may stamp or seal such article with the Corporation stamp or seal and keep the same in the place where it was found, until its disposal as hereinafter provided.

[Articles so stamped or sealed shall be deemed to have been seized under this section, and no person shall remove or in any way interfere with such article without the order of the President.]

[*Explanation.*—Any article exposed, hawked about, deposited in or brought to any place as aforesaid for sale as ghee, which contains any substance not exclusively derived from milk, shall be deemed for the purposes of this section to be an article which is not what it is represented to be.]

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and Hajee Oomar Hajee Ayub Sait, the consignee, were asked to hand over the bags to the Corporation for destruction. Messrs. Binny & Co., Ltd., wrote to say that they were not the owners, and the consignee regretted his inability to hand over the bags for destruction, as they were removed and sold to some of his mufassal customers prior to the receipt of the letter from the Health Officer. So there should be provision in the Act to retain such articles in the premises where they were found until their final disposal. They should be stamped or sealed with the Corporation stamp or seal to distinguish them from the other articles in the premises and to show that they were seized by the Corporation, and any interference with the articles on the part of the owners should render them liable to penalty.

With regard to No. (2)—Whether an article is pure or adulterated can, for the most part, be made out from the mere sight of it, but it cannot be proved as adulterated, unless it is chemically analysed and the nature of the adulterant is found out. Nor can it be said to be unsound, unwholesome or unfit for human food even after analysis unless the adulterant is in itself injurious to health or makes the adulterated article injurious to health by its being mixed with it. So it cannot be seized and destroyed forthwith, just as other articles of food can be done.

Again in many cases it is impossible to carry away the articles as soon as they are seized. To quote a concrete instance, suppose twenty tins of ghee are found in a shop in such an adulterated condition that, in the opinion of the Inspecting Officer, the ghee is either unsound or unfit for human food, and he seizes the tins under section 354. Suppose the owner of the article refuses to give his consent to destroy the article on the ground that in his opinion it is neither unsound nor unfit for human consumption. The ghee cannot, in this case, be taken forthwith before a Magistrate for orders for destruction without definite proof that the article is unsound or unfit for human food. A sample

(3) Meat, subject to the process of blowing, shall be deemed to be unfit for human food.	(3) Meat, subject to the process of blowing, shall be deemed to be unfit for human food.
Section 355. (1) When any article of human food is seized under section 354, it may, with the consent of the owner or the person in whose possession it was found, be forthwith destroyed in such manner as to prevent its being used for human food or again exposed for sale, or,	Section 355. (1) When any article of human food is seized under section 354, it may, with the consent of the owner or the person in whose possession it was found, be forthwith destroyed in such manner as to prevent its being used for human food or again exposed for sale, or,
if such consent be not obtained, then, if any such article is of a perishable nature, and is, in the opinion of the President, the Health Officer, or any Commissioner or any Municipal Officer deputed by the Health Officer diseased, unsound, unwholesome or unfit for human food, it may be destroyed as aforesaid.	if such consent be not obtained, then, if any such article is of a perishable nature, and is, in the opinion of the President, the Health Officer, or any Commissioner or any Municipal Officer deputed by the Health Officer diseased, unsound, unwholesome or unfit for human food, it may be destroyed as aforesaid, [or
	if any such article is adulterated or not what it is represented to be, a sample of such article shall forthwith be sent to the Chemical Examiner to Government or such analyst as the Local Government may appoint for analysis, and on receipt of the analyst's certificate, the same shall be dealt with as hereinafter provided.]
(2) The expenses incurred in destroying any article in pursuance of sub-section (1) shall be paid by the person in whose possession such article was at the time of its seizure.	(2) The expenses incurred in destroying any article in pursuance of sub-section (1) shall be paid by [the owner or] the person in whose possession such article was at the time of its seizure.

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has first to be sent for analysis and if after analysis the analyst certifies that the ghee is injurious to health, then only it may be taken to a Magistrate for orders for destruction. The following questions are to be considered in this case :—

(1) How is the Inspecting Officer to carry away the twenty tins of ghee?

(2) Where is he to keep them from the time of their seizure till he gets a certificate from the analyst?

(3) How can the taking of a sample for analysis be considered to have been legally done, if it is not taken in the owner's presence and a part of it is given to him as required in section 360?

(4) Even supposing that a sample is taken in the owner's presence before the removal of the tins from his permises and a part of the sample is delivered to him, what is there to prevent the owner saying that the sample taken is quite different from the ghee he had, seeing that the ghee is no longer in his custody?

To avoid all these difficulties, provision in necessary to the effect that adulterated articles or articles which are not what they are represented to be need not be carried away from the premises where they are found, but may be kept there under the Corporation seal and under the seal of the owner, if he finds it necessary, until their final disposal. Any person interfering with the article should be punished for the offence.

To get over the difficulties mentioned with regard to (1) and (2), the following clause is added under section 354:—

'If any such article, which is of such size or in such quantity as cannot be carried easily, appears to him to be diseased, unsound, unwholesome or unfit for human food, or if any such article appears to him to be adulterated or to be not what it is represented to be, he may stamp or seal such articles with the Corporation stamp or seal and keep the same in the place where it was found, until its disposal as hereinafter provided.

Section 356. (1) Every animal, article, utensil and vessel seized under section 354 which is not destroyed in pursuance of section 355 shall forthwith be taken before a Magistrate.

(2) If it appears to the Magistrate that any such animal is diseased, or that any such article is unsound, unwholesome or unfit for human food, or is adulterated or is not what it was represented to be, or that any such utensil or vessel is of such kind or in such state as aforesaid, he shall order the same—

(*a*) to be forfeited to the Corporation, or

(*b*). to be destroyed, at the charge of the person in whose possession it was at the time of its seizure, in such manner as to prevent the same being again exposed or hawked about for sale or used for human food or for the preparation or manufacture of or for containing any such article as aforesaid.

Section 356. (1) Every animal and [every article of such size or in such quantity as can be easily carried and samples of every article of such size or in such quantity as cannot be easily carried], seized under section 354 which is not destroyed in pursuance of section 355 shall be taken before a Magistrate in the following manner, namely:—

(*a*) In the case of every article, a sample of which was not sent for analysis, the article or samples of the same shall forthwith be taken before him.

(*b*) In the case of every article, a sample of which was sent for analysis, the article or samples of the same shall after the receipt of the analyst's certificate be taken before him.

(2) If it appears to the Magistrate that any such animal is diseased, or that any such article is unsound, unwholesome, or unfit for human food, or is adulterated or is not what it was represented to be, he shall order the same—

(*a*) to be forfeited to the Corporation, or,

(*b*) to be destroyed, at the charge of [the owner or] the person in whose possession it was at the time of its seizure, in such manner as to prevent the same being again exposed or hawked about for sale or used for human food.

Penal section.
Fine to be fixed.

Articles so stamped or sealed shall be deemed to have been seized under this section, and no person shall remove or in any way interfere with such article without the order of the President '.

An explanation is also added under this clause to bring all imitations of ghee under articles which are not what they are represented to be. This explanation is taken from the Bombay Municipal Act (section 415).

As regards No. (3)—Any utensil or vessel, which, in the opinion of the Inspecting Officer, is of such kind or in such state as to render the article prepared, manufactured or contained therein unwholesome or unfit for human food, cannot be taken before a Magistrate, as soon as it is seized. It is necessary to prove that the article prepared or contained therein has become unsound or unfit for human food by its being in contact with such utensil or vessel. To do this, the article of food should be analysed, and if the analysis reveals that the article has absorbed metallic poison, then the vessel may be taken before a Magistrate for orders for destruction.

Another point to be considered is that it is neither necessary nor possible to destroy a vessel. A vessel which is unfit to be used for manufacturing or containing a particular article of food may be fit to be used for preparing or holding another article of food. And all vessels which are unfit to be used for preparing or containing articles of food may be useful for manufacturing or containing other articles. So the portions of sections 354 and 356 dealing with utensils or vessels may be omitted, and fresh provision made to prohibit under penalty the use of utensils or vessels made of metals which easily corrode and get into the articles of food manufactured or contained in those utensils or vessels.

SECOND AMENDMENT.

Section 353. It shall be the duty of the President to make provision for the constant and vigilant inspection of animals, carcasses, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, milk, ghee, butter, oil and any other article exposed or hawked about for sale or deposited in or brought to any place for the purpose of sale or of preparation for sale and intended for human food, the proof that the same was not exposed or hawked about or deposited or brought for any such purpose or was not intended for human food resting with the party charged.	To be retained as it is.
Section 354. (1) The President may, at all reasonable times, inspect and examine any such animal or article as aforesaid and any utensil or vessel used for preparing, manufacturing or containing any such article.	To be retained as it is.
(2) If any such animal appears to the President to be diseased, or if any such article appears to him to be diseased, unsound, unwholesome or unfit for human food or to be adulterated or to be not what it is represented to be, or if any such utensil or vessel is of such kind or in such state as to render any article prepared, manufactured or contained therein unwholesome or unfit for human food, he may seize and carry away such animal, article, utensil or vessel, in order that the same may be dealt with as hereinafter provided.	(2) If any such animal appears to the President to be diseased [or if any such article, which is of such size or in such quantity as can be easily carried], appears to him to be diseased, unsound, unwholesome or unfit for human food [or if any such utensil or vessel is of such kind or in such state as to render any article prepared, manufactured or contained therein unwholesome or unfit for human food], he may seize and carry away such animal, article, utensil or vessel in order that the same may be dealt with as hereinafter provided. If any such article which is of such size or in such quantity as cannot be carried easily, appears to him to be diseased, unsound, unwholesome or unfit for human food, or if any such article appears to him to be adulterated or to be not what it is represented to be, he may stamp or seal such article with the Corporation stamp or seal and keep the same in the place where it was found, until its disposal as hereinafter provided.

Accordingly in the first amendment suggested, portions of sections 354 and 356 dealing with utensils or vessels have been omitted and an addition has been made in section 353 to empower the President to prescribe the kinds of vessels or utensils to be used for containing or manufacturing articles of food. A clause has also been added in the new section suggested after section 356 to prohibit the use of utensils or vessels other than those prescribed.

If this amendment is not approved, then section 354 may remain as it is so far as the use of utensils or vessels are concerned and additional provision may be made in section 355 to submit to analyses the foods contained or manufactured in the utensils or vessels seized and in section 356 to take such utensils or vessels before a Magistrate after the receipt of the analyst's certificate (*vide* second amendment suggested).

Section 355 is an intervening stage between the act of seizing an article unfit for human food and taking it to a Magistrate. Here a clause is added to submit to analysis samples of articles which are adulterated or are not what they are represented to be, and also samples of articles contained or prepared in any of the utensils or vessels seized, in case the second amendment is adopted.

Penal section. Fine to be fixed.	Articles so stamped or sealed shall be deemed to have been seized under this section, and no person shall remove or in any way interfere with such article without the order of the President. *Explanation.*—Any article exposed, hawked about, deposited in or brought to any place as aforesaid for sale as ghee, which contains any substance not exclusively derived from milk, shall be deemed for the purposes of this section to be an article which is not what it is represented to be.
(3) Meat, subject to the process of blowing, shall be deemed to be unfit for human food.	To be retained.
Section 355. (1) When any article of human food is seized under section 354, it may, with the consent of the owner or the person in whose possession it was found, be forthwith destroyed in such manner as to prevent its being used for human food or again exposed for sale, or	To be retained.
if such consent be not obtained, then, if any such article is of a perishable nature, and is, in the opinion of the President, the Health Officer, or any Commissioner or any Municipal Officer deputed by the Health Officer diseased, unsound, unwholesome or unfit for human food, it may be destroyed as aforesaid.	To be retained.
	If any such article is adulterated or not what it was represented to be, or if any article prepared, manufactured, or contained in any such utensil or vessel is unwholesome or unfit for human food, a sample of such article shall forthwith be sent to the Chemical Examiner to Government or such analyst as the Local Government may appoint for analysis, and on receipt of the analyst's certificate the same shall be dealt with as hereinafter provided.
(2) The expenses incurred in destroying any article in pursuance of sub-section (1) shall be paid by the person in whose possession such article was at the time of its seizure.	To be retained. The words 'the owner or' are to be added between the words 'shall be paid by' and 'the person'.
Section 356. (1) Every animal, article, utensil and vessel seized under section 354 which is not destroyed in pursuance of section 355 shall forthwith be taken before a Magistrate.	Section 356. (1) Every animal and every article of such size or in such quantity as can be easily carried and samples of every article of such size or in such quantity as cannot be easily carried, and every utensil and vessel, seized under section 354 which is not destroyed in pursuance of section 355 shall be taken before a Magistrate in the following manner, namely :— (a) In the case of every article, a sample of which was not sent for analysis, the

It is better if perishable articles are specified or defined. In the absence of definite information on the point, whatever is considered to be a perishable article and destroyed by a sanitary authority in pursuance of this section may be disputed to be an imperishable article by the owner.

Section 356. In cases where the articles seized are in large quantities and cannot be removed easily from place to place, the necessity of taking the articles

	article or samples of the same shall forthwith be taken before him.
	(*b*) In the case of every article, a sample of which was sent for analysis, and in the case of every utensil or vessel, a sample of the food contained in which was sent for analysis, the article or samples of the same and the utensil or vessel shall after the receipt of the analyst's certificate be taken before him.
(2) If at appears to the Magistrate that any such animal is diseased, or that any such article is unsound, unwholesome or unfit for human food, or is adulterated or is not what it was represented to be, or that any such utensil or vessel is of such kind or in such state as aforesaid, he shall order the same—	To be retained.
(*a*) to be forfeited to the Corporation, or (*b*) to be destroyed at the charge of the person in whose possession it was at the time of seizure, in such manner as to prevent the same being again exposed or hawked about for sale or used for human food or for the preparation or manufacture of or for containing any such article as aforesaid	The words ' the owner or ' are to be added between the words ' at the charge of ' and ' the person. '

entirely before a Magistrate may be dispensed with. Only samples may be taken before him and if he finds it necessary to inspect the articles before passing orders, he may inspect them in the places where they are kept after seizure. This is now being deserved. However it is better to have it in the shape of legislation. Hence the suggestion under sub-section (1) that every article of such size or in such quantity as can be easily carried and samples of every article of such size or in such quantity as cannot be easily carried shall forthwith be taken before a Magistrate.

As has already been stated the portions relating to utensils or vessels have been omitted in the first amendment and retained in the second amendment.

Under section 356 (2) damaged articles can now be destroyed only at the charge of the person in whose possession it was found. This is well and good, if the owner and possessor is the same person. But if they are two different persons, difficulty arises. For example, goods at the Port Trust premises can be destroyed only at the cost of the Port Trust authorities under this section, even though the consignee admits ownership. This is rather placing the Port Trust authorities in an inconvenient position for no fault of theirs. To avoid this, it is necessary that the owner also should be made liable to pay the cost of destruction, if he can easily be traced out. So the words ' the owner ' are added between the words ' to be destroyed at the charge of ' and the words ' the person, etc. '

NEW SECTION A.

Fine imposed under Bombay Municipal Act is Rs. 100. *Penal section. Fine to be fixed. Fine imposed under P.H.A., 1875, is £20 or three months' imprisonment.*

Noperson shall keep or expose or hawk about for sale any article of food, which is diseased, unsound, unwholesome or unfit for human consumption, or represent the same to be otherwise than what it really is [and no utensils or vessels other than those of the kind prescribed under section 353 shall be used for preparing, manufacturing or containing any article of food, nor shall the utensils or vessels used in accordance with section 353 be kept in such state as to render the article prepared, manufactured or contained therein unwholesome or unfit for human food].

To be added if the first amendment of the previous sections is adopted.

[And no utensil or vessel of such kind shall be used, nor shall it be kept in such state, as shall render the article prepared, manufactured, or contained therein unwholesome or unfit for human food].

To be added if the second amendment of the previous sections is adopted.

[Provided that when any article represented to be ghee or any other kind of food appears to the Magistrate not to be what it is represented to be, solely by reason of the fact that there has been added to it some substance not injurious to health, no offence shall be deemed to have been committed by the owner of the article or the person in whose possession the same is found, if such owner or person proves to the satisfaction of the Magistrate—

(*a*) that such substance has been added to the article to make the same fit for carriage or consumption, and not fraudulently to increase the bulk, weight or measure or to conceal the inferior quality thereof; or

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New Section A.
Prohibition of sale of unsound article of food.

Mere destruction of an unsound article of food will not affect the owner as keenly as punishment along with the destruction of the article. In England sale or exposure for sale of an unsound article of food is considered to be a serious offence, and as soon as the article is condemned by a justice, not only is it ordered to be destroyed, but also the owner is punished for selling or exposing the same for sale—*vide* section 117 of the Public Health Act, 1875, which is quoted below for information :—

'If it appears to the justice that any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour or milk, so seized is diseased or unound or unwholesome or unfit for the food of man, he shall condemn the same, and order it to be destroyed or so disposed of as to prevent it from being exposed for sale or used for the food of man ; and the person to whom the same belongs or did belong at the time of exposure for sale, or in whose possession or on whose premises the same was found, shall be liable to a penalty not exceeding £20 for every animal, carcase or fish or piece of meat, flesh or fish, or any poultry or game, or for the parcel of food, vegetables, corn, bread or flour, or for the milk so condemned, or at the discretion of the justice, without the infliction of a fine, to imprisonment for a term of not more than three months.'

There is also a similar provision in the Calcutta Municipal Act—*vide* section 496, which runs as follows :—

' No person shall expose or hawk about for sale any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetable, corn, bread, flour, milk, ghee, butter or

(*b*) that in the process of production, preparation or conveyance of such article of food, the extraneous substance has unavoidably become intermixed therewith, or

(*c*) that, by a label distinctly and legibly written or printed on or with the said article of food or by any other means of public description, he has given sufficient notice that such substance has been so added, or

(*d*) that—

i. the said article was purchased by him with a written warranty that it was of a certain nature, substance and quality;

ii. he had no reason to believe that it was not of such nature, substance and quality as aforesaid ;

iii. it was not exposed hawked about, or brought for sale by him otherwise than as an article of the nature, substance and quality specified in the written warranty and was in the same state in which he purchased it.

ADULTERTION OF FOOD AND DRUGS.

Section 357. No person shall sell within the city to the prejudice of the purchaser any article of food or drink or any drug which is not of the nature, substance or quality, of the article demanded by the purchaser.	Section 357. (1) No person shall sell within the city to the prejudice of the purchaser any article of food or any drug which is not of the nature substance or quality, of the article demanded by the purchaser

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other article intended for human food which is diseased, unsound, unwholesome or unfit for human food '.

The Bombay Municipal Act in making a similar provision deals separately with articles which are not what they are represented to be, bringing all imitations of ghee under this category—*vide* sections 417 A and 417 B.

In our act there is no such provision. No doubt by-law 169 supplies the omission, but the fine leviable under it, namely, Rs. 20 is not sufficient, and it does not contain all the requirements.

The new section now suggested to be included in our act is on the lines of sections 417 A and 417 B of the Bombay Municipal Act.

Section 357.
Defects to be remedied.
(1) In sale of adulterated article, no defence to allege purchase for analysis.

The first question which is likely to be raised in a prosecution under this section is whether a Municipal Officer purchasing for analysis can be prejudiced within the meaning of this section. This difficulty has already been experienced here.

In prosecutions in English courts under section 6 by of the Sale of Food and Drugs Act, 1875, of which section 357 of our Act is a reproduction, the above question was raised and in consequence of conflict of opinions expressed by the Judges, the amending provision contained in section 2 of the Sale of Food and Drugs Amendment Act, 1879, was passed. Section 2 of the above act runs as follows :—

' In any prosecution under the provisions of the principal act for selling to the prejudice of the purchaser any article of food or any drug which is not of the nature, substance, and quality of the article demanded by such purchaser, it shall be no defence to any such prosecution to allege that the purchaser, having bought only for analysis, was not prejudiced by such sale, etc.'

A similar provision is necessary in our act. Hence the addition under section 357, as sub-section 2, the following clause, namely :—

' In any prosecution under this section it shall be no defence to allege that the purchaser, having bought only for analysis, was not prejudiced by such sale.

Provided that an offence shall not be deemed to be committed under this section in the following cases, namely :—	Provided that an offence shall not be deemed to be commitred under this section in the following cases, namely :—
(*a*) where any matter or ingredient not injurious to health has been added to such food or drink or drug to make the same fit for carriage or consumption, and not fraudulently to increase the bulk, weight or measure or to conceal the inferior quality thereof ;	(*a*) where any matter or ingredient not injurious to health has been added to such food or drug to make the same fit for carriage or consumption, and not fraudulently to increase the bulk, weight or measure or to conceal the inferior quality thereof ;
(*b*) where such food or drug is a proprietary medicine or is the subject of a patent in force and is supplied in the state required by the specification thereof ;	(*b*) where such food or drug is a proprietary medicine or is the subject of a patent in force and is supplied in the state required by the specification thereof ;
(*c*) where such food or drink is a compound article or such drug is compounded ; and	(*c*) where such food or drug has been unavoidably mixed with some extraneous matter in the process of collection or preparation.
(*d*) where such food, drink or drug has been unavoidably mixed with some extraneous matter in the process of collection or preparation.	(*d*) [where any matter or ingredient not injurious to health has been added to or mixed with such article of food and, before the sale thereof, the seller has brought to the notice of the purchaser, by means of a label distinctly and legibly written or printed on or with the article, the fact that such matter has been so added or mixed.]

Section 357.
Defects to be remedied.
(2) Protection from offences by giving label.

Similar provision exists in the Calcutta Municipal Act and the Bombay Prevention of Adulteration Act—*vide* section 495 (2) of the former and section 3 (3) of the latter.

Section 2 of the Sale of Food and Drugs Amendment Act, 1879, contains, beside the above provision, also the following :—

'Neither shall it be a good defence to prove that the article of food or drug in question, though defective in nature or in substance or in quality, was not defective in all three respects.'

This enactment was rendered necessary on account of the wording of section 6 of the Sale of Food and Drugs Act, 1875, which is that 'No person shall sell to the prejudice of the purchaser, any article of food or any drug which is not of the nature, substance, AND quality of the article demanded by the purchaser', instead of that 'No person, etc. . . . . . which is of the nature, substance, OR quality of the article demanded by the purchaser', and the consequent opinions expressed by certain of the Judges of the Scotch Court to the effect that the words, 'nature, substance AND quality' in this section meant that, in order to prove adulteration, a prosecutor must prove that an article is defective in all three respects, and not only in one or more of them. This provision is unnecessary in our act inasmuch as section 357 is rightly worded in this respect.

A seller may get outside section 357 by notifying to the purchaser either in writing or verbally that the article sold is mixed, provided the notice be unequivocal and brought to the knowledge of the purchaser. In the absence of any express enactment to the effect that the notice should be unequivocal and that it should be distinctly written or printed on the article of food or drug sold, the seller may display the notice in some obscure corner of his premises to avoid the same being seen by the purchaser or may say that a verbal notice was given to the purchaser at the time of sale, while in fact no notice was given to him at all. The same difficulty was felt in England and the defect was remedied by section 8 of the Sale of Food and Drugs Act, 1875, and section 12 of the Sale of Food and Drugs Act, 1899.

Section 8 of the Sale of Food and Drugs Act, 1875, is—

'Provided that no person shall be guilty of any such offence as aforesaid in respect of the sale of an article of food or a drug mixed with any matter or ingredient not injurious to health, and not intended fraudulently to increase its

[*Explanation.*—(1) If in compliance with a demand for ghee any article is supplied which contains any substance not exclusively derived from milk, such article shall be deemed to have been sold to the prejudice of the purchaser, unless before the sale thereof the seller has brought to the notice of the purchaser that it contains such substance.]

[(2) In any prosecution under this section, it shall be no defence to allege that the purchaser, having bought only for analysis, was not prejudiced by such sale.]

[(3) The Court may presume that any article of food or drink found in the possession of a person who is in the habit of manufacturing like articles has been manufactured for sale.]

[(4) In any prosecution under this section, it shall be no defence to allege that the vendor was ignorant of the nature, substance, or quality of the article sold by him.

Provided that the vendor shall not be deemed to have committed an offence under this section, if he proves to the satisfaction of the Court—

(*a*) that the article was purchased by him as the same in nature, substance and quality as that demanded by the purchaser, and with a written warranty to the effect that it was of such nature, substance and quality;

(*b*) that he had no reason to believe at the time when he sold it that the article was not of such nature, substance and quality as aforesid; and

(*c*) that he sold it in the same state in which he purchased it.]

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bulk, weight, or measure, or conceal its inferior quality, if at the time of delivery of such article or drug he shall supply to the person receiving the same a notice, by a label distinctly and legibly written or printed on or with the article or drug, to the effect that the same is mixed.'

Section 357.
Defects to be remedied.

Section 12 of the Sale of Food and Drugs Act of 1899 says that the label referred to in the above section shall not be deemed to be distinctly and legibly written or printed within the meaning of that section, unless it is so written or printed that the notice of mixture given by the label is not obscured by other matter on the label.

Section 3 (1) (*c*) of the Bombay Prevention of Adulteration Act, 1899, contains a similar provision together with an explanation under it to the effect that if in compliance with a demand for ghee any article is supplied which contains any substance not exclusively derived from milk, such article shall be deemed to have been sold to the prejudice of the purchaser, unless before the sale thereof the seller has brought to the notice of the purchaser the fact that it contains such substance. The addition suggested to be made under section 357 of our act is on the above lines—*vide* sub-section (1) (*d*) in square brackets under section 357.

(3) Want of knowledge of adulteration without a written warranty is no defence.

It is no defence for a prosecution under this section for the respondent to plead want of knowledge of the adulteration at the time of sale unless at the same time he produces in defence a written warranty. Section 495 (2) of the Calcutta Municipal Act says that it shall be no defence to allege that the vendor or manufacturer was ignorant of the nature, substance or quality of the article sold

Section 358. No person shall sell any compound article of food or drink or compounded drug which is not composed of ingredients in accordance with the demand of the purchaser.	To be retained. The words 'or drink' to be omitted, as drink is included in the proposed definition of 'Food'.
Provided that no person shall be deemed guilty of an offence under this section in respect of any food, drink or drug mixed with any harmless matter or ingredient, if at the time of delivering the same he gives the purchaser notice that the said article is mixed.	Do.
Section 359. No persan shall— (*a*) abstract from any article of food any part thereof so as to affect injuriously the quality, substance or nature of such article with intent that it should be sold in its altered state without notice ; or (*b*) sell any article so altered without making disclosure of the alteration.	To be retained.
Penal section. Fine to be fixed. Fine under the Sale of Food and Drugs Act, 1875, is £50 for the first offence and six months' rigorous imprisonment for any subsequent offence.	NEW SECTION B. No person shall mix, colour, stain, or powder or order or permit any other person to mix, colour, stain or powder any article of food with any ingredient or material so

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or manufactured by him, and makes no mention of warranty. Section 3 (3) of the Bombay Prevention of Adulteration Act, 1899, besides containing the above clause, has also a proviso under it on the lines of section 25 of the Sale of Food and Drugs Act, 1875, which runs as follows :—

Section 25 of the Sale of Food and Drugs Act, 1875.

'If the defendant in any prosecution under this act prove to the satisfaction of the justices or court that he had purchased the article in question as the same in nature, substance, and quality as that demanded of him by the prosecutor, and with a written warranty to the effect, that he had no reason to believe at the time when he sold it that the article was otherwise, and that he sold it in the same state as when he purchased it, he shall be discharged from the prosecution, but shall be liable to pay the costs incurred by the prosecutor, unless he shall have given due notice to him that he will rely on the above defence.'

The addition suggested to be made under section 357 of our act, as sub-section (4) is on the lines of section 3 (3) of the Bombay Prevention of Adulteration Act, 1899.

Section 495 of the Calcutta Municipal Act, dealing with the prohibition of the sale of articles of food not of the nature demanded, lays down that in a prosecution under that section the Court may presume that any article of food or drink found in the possession of a person who is in the habit of manufacturing like articles has been manufactured for sale. A similar provision in our act will be a great help in dealing with the professional adulterated ghee sellers in the city. Hence it is added to section 357 as sub-section (3).

The existing proviso (*c*) under section 357 about compound article or compounded drug is omitted in the proposed amendment, as there is a separate section dealing with such articles or drugs.

New section B.
Mixing articles of food with injurious ingredients.

It is a common occurrence in the sweetment bazaars, coffee hotels and other places in the city, where sweets or other articles of food are manufactured or exposed for sale, to colour or mix such articles with various powders and other ingredients supposed to be injurious to health. To put an end to such practice,

Penal section. Fine to be fixed. Fine ~~under the Hongkong~~ Ordinance is 100 *dollars or three months' imprisonment with or without hard labour.*

as to render the article injurious to health; and no person shall sell or expose for sale any such article so mixed, coloured, stained or powdered.

Provided that an offence shall not be deemed to be committed under this section in the following cases, namely:—

(*a*) Where an article of food is adulterated by reason only of the addition of any preservative or colouring matter of such a nature and in such a quantity as not to render the article injurious to health;

(*b*) Where the seller or his agent proves to the satisfaction of the Court that he did not know of the article of food sold by him being so mixed, coloured, stained or powdered, and that he could not with reasonable diligence have obtained that knowledge.

NEW SECTION C.

Every tin or other receptacle containing condensed, separated or skimmed milk sold or exposed for sale for consumption in the city shall bear a label; and on every such label and on the wrapper, if any, of every such tin or other receptacle there shall be printed in large and legible type in English, Tamil, Telugu and Hindustani the words 'This is skimmed milk. Children under one year of age should not be fed on it'; and no person shall sell or expose or offer for sale for consumption in the city condensed, separated or skimmed milk in contravention of this section.

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this section is necessary. It is framed on the lines of sections 3 and 5 of the Sale of Food and Drugs Act, 1875.

New section C.

Provision as to condensed, separated or skimmed milk sold for consumption in the city.

Condensed, skimmed or separated milk is largely used by poor and ignorant people in the city for infant-feeding, and there can be no doubt that the increase in the infantile mortality is mainly due to the consumption of this milk.

The labels on many of the tins of inferior condensed milk bear the words 'skimmed or separated' in such small type that the intimation might be easily overlooked. It should, therefore, be made compulsory to print on every such label in large and legible type, in English and in the vernacular languages prevailing in the city the words 'This is skimmed milk. Children under one year of age should not be fed on it'. The section suggested is taken from the Sale of Food and Drugs Amendment Ordinance of Hongkong (section 10 *a*).

NEW SECTION D.

(1) The Local Government may make regulations for determining what deficiency in any of the normal constituents of genuine milk, cream, butter, ghee, or cheese, or what addition of extraneous matter or proportion of water, in any sample of milk (including condensed milk), cream, butter, ghee, or cheese, shall, for the purposes of this act, raise a presumption, until the contrary is proved, that the milk, cream, butter, ghee, or cheese is not genuine or is injurious to health, and an analyst shall have regard to such regulations in certifying the result of an analysis under this act.

(2) Any regulations made under this section shall be notified in the *Fort St. George Gazette*, and shall also be made known in such other manner as the Local Government may direct.

NEW SECTION E.

Penal section. Fine to be fixed.

Every package, tin or other receptacle, whether open or closed, and containing ghee or margarine, shall be branded or durably marked 'Ghee' or 'Margarine,' as the case may be, on the top, bottom and sides in printed capital letters not less than three-fourths of an inch square in English and in any of the vernacular languages, and if any ghee or margarine be exposed or hawked about for sale by retail, there shall be attached to each tin or receptacle thereof so exposed or hawked about, and in such manner as to be clearly visible to the purchaser, a label marked in printed capital letters not less than one and a half inches square 'Ghee' or 'Margarine'; and no person shall deal with or sell, or expose or hawk about or offer for sale, or keep in his possession for the purpose of sale, any quantity of ghee or margarine in contravention of this section.

New section D.

Power to make regulations as to analysis of milk, cream, butter, ghee or cheese.

This section is necessary to empower the Local Government to make regulations as to analysis of milk, ghee or butter after the fixation of standards. This is also taken from the Sale of Food and Drugs Amendment Ordinance of Hongkong (section 28), which is on the lines of section 4 of the Sale of Food and Drugs Act, 1899.

New section E.

Making of cases, tins or other receptacles containing ghee or margarine.

This section is intended to prevent ghee sellers from cheating the public. Every shop-keeper in the city exposes for sale more than one kind of ghee. In the absence of marks or labels on the tins or other receptacles of ghee, the purchaser may be shown a sample of pure ghee from one tin and supplied with adulterated ghee from another tin, without the same being noticed by him. And even if the purchaser notices it, he cannot proceed against the vendor and even if he proceeds, he cannot substantiate the charge, as the seller will surely defend himself by saying that he gave him ghee from the very tin from which the sample shown to him was taken. If the tins bear marks, and if after purchasing ghee from the tin marked 'Ghee' the purchaser finds the article to be other than ghee, he can proceed against the vendor for this offence.

This section is taken from sections 6 and 7 of the Margarine Act, 1887.

NEW SECTION F.

All ghee or margarine brought to the city of Madras, and all ghee or margarine manufactured within the city, shall whenever forwarded by any public or private conveyance be duly consigned as ghee or margarine, and it shall be lawful for the President (the Health Officer, Assistant Health Officers, Food Inspectors, Sanitary Inspectors), or any other officers appointed by the President, if he shall have reason to believe that the provisions of this chapter are infringed on this behalf, to examine and take samples from any package, tin or other receptacle, either in the Railway Stations or on roads during the course of transit, and ascertain, if necessary, by submitting the same to be analysed, whether an offence against this act has been committed.

NEW SECTION G.

Where an employer is charged with an offence against any of the sections of this chapter he shall be entitled, upon information duly laid by him, to have any other person whom he charges as the actual offender brought before the Court at the time appointed for hearing the charge, and if, after the commission of the offence has been proved, the employer proves to the satisfaction of the Court that he had used due diligence to enforce the execution of this act and that the said other person had committed the offence in question without his knowledge, consent, or connivance, the said other person shall be summarily convicted of such offence, and the employer shall be exempt from any penalty.

Section 360. The President may require any seller of any food or drug to sell the same, or part thereof, to him with the intention of submitting the same to analysis, and shall after the purchase is completed—	Section 360. The President may require any seller [or his agent or any importer, consignor or consignee, or his agent] to sell to him any article of food or drug or part thereof, [exposed for sale or on sale by retail on any premises or in any shop or stores or on any street or open place of public resort or deposited in or brought to any place within the city for the purpose of sale], with the intention of submitting

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New section F.
Ghee or margarine imported or manufactured.

This section gives power to take samples of ghee and imitations of ghee in Railway Stations and on roads in the course of transit. This is quite essential to check the importation of adulterated ghee into the city. This section is taken from section 8 of the Margarine Act, 1887.

New section G.

This section exempts innocent employers from punishment. This is taken from section 5 of the Margarine Act, 1887.

Section 360.

If the additional powers asked for are given, it will be necessary to take samples of food for analyses, wherever it is found, whether in shops or stores or on any street or any place of public resort, and the person, in whose custody or control such article is for the time being, should be made to sell it. Hence the additions in square brackets in this section.

(*a*) forthwith notify such intention to the seller;

(*b*) divide the article into three parts, each of which shall then and there be separated, marked and sealed or fastened up;

(*c*) deliver one of the parts to the seller;

(*d*) retain one of the parts for future comparison; and

(*e*) if he thinks fit, furnish the third part to the Chemical Examiner to Government or such analyst as the Local Government may appoint in this regard.

the same to analysis, and shall after the purchase is completed—

(*a*) forthwith notify such intention to the seller;

(*b*) divide the article into three parts, each of which shall then and there be separated, marked and sealed or fastened up;

(*c*) deliver one of the parts to the seller;

(*d*) retain one of the parts for future comparison; and

(*e*) if he thinks fit, furnish the third part to the Chemical Examiner to Government or such analyst as the Local Government may appoint in this regard.

NEW SECTION H.

If the seller or his agent, or the importer, consignor, or consignee, or his agent does not accept the offer of the President to divide the article purchased in his presence, the analyst receiving the article for analysis shall divide the same into two parts, and shall seal or fasten up one of those parts, and shall cause it to be delivered, either upon receipt of the sample or when he supplies his certificate to the President, who shall retain the same for production in case proceedings shall afterwards be taken in the matter.

NEW SECTION K.

(1) The President may procure at the place of delivery any sample of any milk or any other article of human food in course of delivery to any purchaser or consignee, and if he suspects the same to have been sold contrary to any of the provisions of this chapter, he shall submit the same to be analysed; and the same shall be analysed and proceedings shall be taken and penalties on conviction be enforced in

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The additional words in square brackets are taken from section 17 of the Sale of Food and Drugs Act, 1875, and section 5 of the Sale of Food and Drugs Amendment Act, 1879.

New section H.
Provision when sample is not divided.

Section 360 of our act is identical with section 14 of the Sale of Food and Drugs Act of 1875. Under it the sample purchased shall be divided into three parts, one to be delivered to the seller, one to be retained by the purchaser for future comparison and the third to be sent to the analyst. But the further procedure to be adopted, in case the seller does not accept the offer of the purchaser to divide the sample, is not given in our act, but it is stated in the Sale of Food and Drugs Act, 1875, under section 15. Hence this section on the lines of section 15 of the Sale of Food and Drugs Act, 1875.

New section K.
Taking samples in course of delivery.

It is necessary to take samples from adulterated articles including milk, while they are in the course of delivery to the purchasers or consignees, after sale or in pursuance of any contract for the sale to such person. Hence this section, on the lines of section 3 of the Sale of Food and Drugs Act, 1875, and section 14 of the Sale of Food and Drugs Act, 1899.

like manner in all respects as if the President had purchased such sample from the seller or consignor under section 360 of this act.

(2) In the case of a sample taken of milk in course of delivery, the President may divide the same only into two parts, deliver one part to the seller or consignor, and submit the other part to the analyst to be analysed.

NEW SECTION L.

The President may, without going through the form of purchase provided by this act, but otherwise acting in all respects in accordance with the provisions of the said Act as to dealing with samples, take for the purpose of analysis samples of any ghee or butter or substances purporting to be butter or ghee, which are exposed for sale or deposited in or brought to any place for the purpose of sale or are in the course of transit, and are not marked 'Margarine' as provided by this act; and any substance not being so marked shall be presumed to be ghee or butter.

NEW SECTION M.

Penal section. Fine to be fixed.

No person shall wilfully obstruct or impede the President or any Municipal Officer deputed by him in the course of his duties under the food and drugs chapter of this act, or by any gratuity, bribe, promise, or other inducement prevent or attempt to prevent the due execution by such officer of his duty under the aforesaid chapter.

NEW SECTION N.

The certificate of the analysis shall be in the from set forth in the schedule hereto, or to the like effect.

In the case of milk which does not keep for more than a day, it is unnecessary to divide the sample into three parts and retain one with the purchaser for future comparison. It may be divided only into two parts. Hence sub-section (2) under this section.

New section L.
Power to take samples without purchase.

In taking samples of ghee and all imitations of ghee found in Railway Stations or in the course of transit from the Railway Stations to the consignee's godown within the city, it is impossible to go through the form of purchase provided by section 360. Hence this section on the lines of section 10 of the Margarine Act of 1887.

New section M.

Obstruction of officer in discharge of his duties.

New section N.

Form of Certificate.

The necessity for these two sections is self-evident.

SCHEDULE

Form of Certificate

To [1] ______________________________

I, the undersigned, public analyst for the ______________________________,
do hereby certify that I received on the ______ day of ______________ 19____,
from [2] ______________________ a sample of ______________________ for
analysis (which, when weighed, [3] ______________________), and have analysed the
same, and declare the result of my analysis to be as follows:—

I am of opinion that the same is a sample of genuine ______________________
or ______________________________

I am of opinion that the said sample contained the parts as under, or the
percentages of ~~foreign ingredients as under~~—

Observations[4]

As witness my hand this day of 19 .

~~A. B.~~

At ______________

[1] Here insert the name of the person submitting the article for analysis.

[2] Here insert the name of the person delivering the sample.

[3] When the article cannot be conveniently weighed, this passage may be erased or the blank may be left unfilled.

[4] Here the analyst may insert at his discretion his opinion as to whether the mixture (if any) was for the purpose of rendering the article portable or palatable, or of preserving it, or of improving the appearance, or was unavoidable, and may state whether in excess of what is ordinary, or otherwise, and whether the ingredients or materials mixed are or are not injurious to health.

In the case of a certificate regarding milk, butter, or any article liable to decomposition, the analyst shall specially report whether any change had taken place in the constitution of the article that would interfere with the analysis.

NEW SECTION O.

(1) No person shall import into the city of Madras any of the following articles, namely:—

(*a*) Margarine or margarine-cheese except in packages or tins conspicuously marked 'Margarine' or 'Margarine-cheese,' as the case may require.

(*b*) Adulterated or impoverished butter, or adulterated or impoverished milk or cream, except in packages or cans conspicuously marked with a name or description indicating that the butter or milk cream has been so treated.

(*c*) Condensed, separated or skimmed milk, except in tins or other receptacles which bear a label whereon the words 'This is skimmed milk. Children under one year of age should not be fed on it,' are printed in large and legible type in English and in the vernacular languages prevailing in the City.

(*d*) Any adulterated or impoverished article of food to which the Local Government may by notification direct that this section shall be applied, unless the same be imported in packages or receptacles conspicuously marked with a name or description indicating that the article has been so treated.

(2) The Customs authorities of Madras shall take such samples of consignments of imported articles of food as may be necessary for the enforcement of the foregoing provisions of this section and send such samples to the local Health authorities for analyses and such subsequent action as may be necessary.

(3) In any proceeding under this section the certificate of the Chemical Examiner to Government or such analyst as the Local Government may appoint in this regard shall be sufficient evidence of the facts therein stated, unless the defendant requires that the person who made the analysis be called as a witness.

(4) For the purposes of this section an article of food shall be deemed to be adulterated or impoverished if it has been mixed with any other substance, or if any part of it has been abstracted so as in either case to affect injuriously its quality, substance, or nature.

Provided that an article of food shall not be deemed to be adulterated by reason only of the addition of any preservative or colouring matter of such a nature and in such a quantity as not to render the article injurious to health.

New section O. This section is introduced in accordance with the suggestion contained in paragraph (6) of the letter of the Government of India on the subject.

NEW SECTION P.

The President may, at all reasonable times board any vessel or steamer lying in the Madras Port and inspect any article of human food found on board such vessel or steamer.

If any such article appears to him to be diseased, unsound, unwholesome or unfit for human food, or to be adulterated or to be not what it is represented to be, he may prevent the same from being landed.

Explanation.—Any article of human food brought in by such vessel or steamer for sale within the city as ghee, which contains any substance not exclusively derived from milk, shall be deemed for the purposes of this section to be an article which is not what it is represented to be.

NEW SECTION Q.

Penal section. Fine to be fixed.

No person shall in any manner prevent the President or any Municipal Officer deputed by him from going on board any vessel or steamer and inspecting any article of human food found on board such vessel or steamer.

New section P. and Q.

These sections are intended to prevent impure food stuffs from being landed. Instead of allowing such stuffs first to land and then take action to prevent them from being sold within the city, it is better to prevent them from being landed at all. This will facilitate the work of the local health authorities and at the same time prevent unsound and impure foods from entering the city by sea. No doubt the Local Government has power to make rules for the inspection of vessels bringing in impure foods under the Indian Ports Act, 1908—*vide* section 6 (1) (*p*) (vii) which is quoted below for information. But unless there is such provision in the Municipal Act, no prompt action can be taken by the local health authorities.

Section 6 (1) (*p*) (vii) of the Indian Ports Act, 1908.

Section 6 (1). The Local Government may, in addition to any rules which it may make under any other enactment for the time being in force, make such rules, consistent with this act, as it thinks necessary for any of the following purposes, namely :—

. . . .

(*p*) with the previous sanction of the Governor-General in Council . . and for regulating the action, . . to be taken.

(vii) where there are on board a vessel in any such port food stuffs which, owing to decomposition or for any other reason, are, in the opinion of the Health Officer, unfit for human consumption.

Existing section.	*Proposed amendment.*
Section 409. The Corporation may, and shall, if the Local Government so direct, make by-laws, not being inconsistent with the provisions of this act, to provide for	Section 409. The Corporation may, and shall, if the Local Government so direct, make by-laws, not being inconsistent with the provisions of this act, to provide for
(19) the prevention of the sale or exposure for sale of unwholesome meat, fish or provisions ; and securing the efficient inspection and sanitary regulation of shops in which articles intended for human food, or drugs, are kept or sold ;	(19) the prevention of the sale or exposure for sale of unwholesome meat, fish or provisions ; and securing the efficient inspection and sanitary regulation of shops in which articles intended for human food, or drugs, are kept or sold, and for securing the efficient control of the places where such articles of food are manufactured for sale.

Additional by-laws required under section 409 (19).

(1) No person shall sell or expose for sale aërated or sweet waters either on streets, or in stalls in markets, or in shops, or in any other place within the city without having thereon the trade label of the manufacturer from whom he obtained the waters. The trade labels shall be affixed on the sides, but not on the mouths of the bottles containing such waters.

(2) The Health Officer or any other officer deputed by him may seize bottles ~~of aërated~~ or sweet waters, which do not bear the label of the manufacturer, under the presumption that being without a label such waters are inferior in quality and dangerous to public health.

(3) The second class aërated water factories shall intimate to the Health Officer beforehand their desire to work overtime during nights whenever necessary and shall have special permission from him.

(4) Every sweetmeat bazaar or coffee hotel or any other place where articles of food are sold or exposed for sale shall have a board, in front of the place where such articles are exposed for sale, containing in large and legible letters a description of the articles exposed for sale therein and whether they are prepared or manufactured in ghee or margarine or kusumba or in any other oils.

(5) Every sweetmeat bazaar or coffee hotel or any other place where articles of food are manufactured and exposed for sale shall have separate and sufficient accommodation for manufacturing, storing and exposing such articles for sale.

(6) Any person offending against any of these by-laws shall be punishable with a fine which may extend to rupees, and, in the case of a continuing breach, with a fine which may extend to rupees for every day during which the breach continues after conviction for the first breach.

NOTE.

The addition under section 409 (19) is suggested in order to bring aërated water factories under our control. Unless this is passed, by-law No. 3 cannot be passed.

By-laws Nos. 1 to 3 are necessary to put an end to the system of hiring waters in aërated water factories and the consequent issue and sale of impure waters.

By-law No. 4 is necessary to put an end to the general complaint that sweets and other foods are prepared in sweetmeat bazaars and coffee hotels in undesirable imitations of ghee and various oils, and sold to the prejudice of the purchasers.

By-law No. 5 is intended to keep the places where articles of food are manufactured for sale in a sanitary condition.

Existing section.	*Proposed amendment.*
Section 328. (1) Every owner or occupier of a bake-house or manufactory of ice or aërated waters shall, within the first month of every year or, in the case of a bake-house or manufactory to be newly opened, within thirty days before the opening of the same, apply to the President for a license. (2) The President may, by an order, and under such restrictions and regulations as he thinks fit, grant such license or refuse to grant the same.	Section 328. (1) Every owner or occupier of a bake-house or manufactory of ice or aërated waters [or sugar or sugarcandy] shall, etc.

NOTE.

Section 328.

There are nearly fifteen factories in the city where sugar and sugarcandy are manufactured. They are kept in a very insanitary condition. At present they are licensed under section 328, though there is no provision for it under that section. The result is that we can neither recover license fees in cases where the parties refuse to pay license fees, nor grant conditional licenses and take action for failure to fulfil the conditions. Hence the suggestion to include sugar factories under section 328.

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